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# Soil Survey

# Johnson County Indiana

By

H. P. ULRICH, in Charge, T. E. BARNES, A. P. BELL
SUTTON MYERS, T. E. NIVISON, and P. T. VEALE
Purdue University Agricultural Experiment Station

with a section on
Management of the Soils of Johnson County
By
A. T. WIANCKO
Purdue University Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

## HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS PROVIDE a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

**Readers interested in the area as a whole** include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) General Nature of the Area, in which location and extent, physiography, relief, and drainage, climate, water supply, vegetation, organization and population, industries, transportation and markets, and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Estimated Yields and Productivity Ratings, in which the productivity of the soils is given and a grouping of them presented according to their relative physical suitability for agricultural use, and (4) Management of the Soils, in which present uses are described, management requirements discussed, and suggestions made for improvement.

**Readers interested chiefly in specific areas**—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Estimated Yields and Productivity Ratings and Management of the Soils.

**Students and teachers of soil science and allied subjects**—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on General Nature of the Area, Agriculture, Estimated Yields and Productivity Ratings, and the first part of the section on Soils of particular value in determining the relation between their special subjects and the soils of the area.

This publication on the soil survey of Johnson County, Ind., is a cooperative contribution from the —

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

ROBERT M. SALTER, *Chief*

Division of Soil Survey

CHARLES E. KELLOGG, *Chief*

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

H. J. REED, *Director*

A. T. WIANCKO, *Chief, Department of Agronomy*

T. M. BUSHNELL, *Associate in Soil Survey*

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# SOIL SURVEY OF JOHNSON COUNTY, INDIANA

By H. P. ULRICH, in Charge, T. E. BARNES, A. P. BELL, SUTTON MYERS, T. E. NIVISON, and P. T. VEALE, Purdue University Agricultural Experiment Station

Area inspected by JAMES THORP, Principal Soil Scientist, Division of Soil Survey

United States Department of Agriculture in cooperation with the Purdue University Agricultural Experiment Station[1]

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[1] Soil map for part of county based in part on survey of the Stotts Creek-Indian Creek Watershed made by J. A. Elwell, S. A. Lytle, and T. J. Longwell, Soil Conservation Service, U. S. Department of Agriculture.

AGRICULTURE is the leading industry in Johnson County. Farming—centered around corn, wheat, and hay—began with the arrival of the first few settlers, about 1820, but the most marked development followed 1850, when the building of railroads opened new markets and encouraged a more diversified agriculture, including livestock production. At present, the main field crops are corn, wheat, oats, soybeans, and hay—corn being the most important both in acreage and value Livestock is the major source of farm income. A large part of the field crops is fed on the farm to beef and dairy cattle, swine, sheep, and poultry. Vegetable crops, principally tomatoes, sweet corn, and peas, are processed and canned. The county is well provided with plants for processing dairy, grain, and vegetable products, but other manufacturing is limited to small factories that produce household and office furniture, filing equipment, millwork, underwear, auto accessories, and sewing-machine cabinets. To provide a basis for the best agricultural use of the land, a cooperative soil survey was begun in 1938 by the United States Department of Agriculture and the Purdue University Agricultural Experiment Station. The essential features may be summarized as follows.

## SUMMARY

Johnson County, in the central part of Indiana, is divided into three distinct physiographic regions: (1) Scottsburg Lowland, (2) Norman Upland, and (3) Tipton Till Plain. The southeastern part is within the Scottsburg Lowland region. This includes rather wide bottom lands adjacent to the Blue and Driftwood Rivers, Sugar Creek, and their tributaries, and broad glaciofluvial outwash plains and terraces. The Norman Upland region lies immediately west of the Scottsburg Lowland and occurs as a bold escarpment rising more than 200 feet above the surrounding areas. The Tipton Till Plain covers the rest, or more than three-fourths of the county. This is in general a constructional glacial plain only slightly modified by stream dissection, except in the southwestern and western parts.

The soils are of wide variation in color, natural drainage conditions, fertility, consistence, slope, and susceptibility to erosion, and are grouped in four main divisions: (1) Soils of the uplands, (2) soils of the glaciofluvial outwash plains and terraces, (3) soils of the overflow bottoms, and (4) organic soils in upland depressions.

The soils of the uplands are grouped on the basis of their development on parent material as follows: (1) On calcareous Late Wisconsin glacial drift; (2) on calcareous Early Wisconsin glacial drift; (3) on calcareous Illinoian glacial drift; (4) on medium-grained sandstone, siltstone, and shale of the Borden formation; and (5) on calcareous wind-deposited sand and silt of Wisconsin glacial age.

Soils developed on calcareous Late Wisconsin glacial drift—the Bellefontaine, Miami, Crosby, Bethel, Brookston, and Clyde series—comprise about 65 percent of the total area and about 85 percent of the upland. All are developed on calcareous till composed of unassorted silt, clay, sand, and rock fragments, except the Bellefontaine soils, which are developed on loose calcareous gravel and sand, and all are leached of lime carbonates to a depth of about 36 inches.

Soils developed on calcareous Early Wisconsin glacial drift—the Bellefontaine, Russell, Fincastle, Delmar, Brookston, and Clyde series—

occupy about 10 percent of the area. They are developed on calcareous glacial drift, with the exception of the Bellefontaine soils, which are developed on loose calcareous gravel and sand, and all are leached of lime carbonates to a depth of about 45 inches.

Soils developed on calcareous Illinoian glacial drift—the Cincinnati, Gibson, and Avonburg series—are developed on unassorted glacial drift similar to that of the Early Wisconsin and Late Wisconsin glaciation, and lime carbonates have been leached to a depth of about 120 inches. The acidity of the surface and subsoil layers is greater than in the corresponding layers of the soils developed on Wisconsin glacial drift.

Soils developed on medium-grained sandstone, siltstone, and shale of the Borden formation—the Muskingum, Zanesville, and Wellston series—occupy less than 1 percent of the area and occur in the extreme south-central to southwestern part, west of Peoga. The surface and subsoil layers are strong to very strongly acid.

The only soil developed on calcareous wind-deposited sand and silt of Wisconsin glacial age is Princeton fine sandy loam, which is well to excessively drained and light-colored and occurs on nearly level to rolling relief, often in dunelike areas.

Soils of the glaciofluvial outwash plains and terraces are grouped into soils developed (1) on stratified calcareous gravel and sand and (2) on stratified calcareous silt and sand, with small quantities of gravel and clay.

The soils developed on calcareous stratified gravel and sand of Wisconsin age—the Fox, Nineveh, Homer, Westland, and Abington series—comprise 7.6 percent of the area, occupying terraces and outwash plains, principally the terraces in the valleys of the rivers and larger streams and the outwash plains in the eastern part.

Soils developed on calcareous stratified silt and sand, with minor quantities of clay and gravel—the Martinsville, Whitaker, and Mahalasville series—occupy only 4.2 percent of the area and occur principally on the terraces in the valleys of the larger streams and rivers and on the outwash plains in the eastern part.

The soils of overflow bottoms are grouped into soils (1) on neutral to slightly alkaline alluvium from Wisconsin glacial drift regions and (2) on strongly acid alluvium from Illinoian glacial drift and Borden sandstone, siltstone, and shale regions.

Soils of overflow bottoms on neutral to slightly alkaline alluvium from Wisconsin glacial drift regions—the Genesee, Ross, and Eel series—occupy 10.3 percent of the area.

Soils of overflow bottoms on strongly acid alluvium from Illinoian glacial drift and Borden sandstone, siltstone, and shale regions—the Pope and Philo series—occur adjacent to the small streams. They are very inextensive, covering only about 0.3 percent of the county.

Carlisle silty muck, the only organic soil in upland depressions, occupies areas in the Wisconsin glacial regions and is very inextensive. It consists of an accumulation of plant remains, with a considerable quantity of silty mineral material in the surface and subsurface layers.

Johnson County lies in the region of Gray-Brown Podzolic soils of the east-central part of the United States. Most of the soils have developed under a heavy forest cover of deciduous trees, with sufficient rainfall to maintain a moist condition throughout the soil, except for short periods.

The four different geologic formations or sources of material from which the parent material is derived are Late Wisconsin glacial drift, Early Wisconsin glacial drift, Illinoian glacial drift, and Borden or Knobstone

(Lower Mississippian) sandstone, siltstone, and shale. On the basis of their characteristics the soils are classified into zonal, intrazonal, and azonal soils.

Soil management points out the deficiencies of the several soils and in general outlines the treatments most needed and most likely to produce satisfactory results.

## GENERAL NATURE OF THE AREA

### LOCATION AND EXTENT

Johnson County, in the central part of Indiana (fig. 1), is rectangular in shape, the north-south length being about 20 miles and the east-west width about 16 miles. The area is 322 square miles, or 206,080 acres.

Franklin, the county seat, is 20 miles southeast of Indianapolis, the State capital; about 84 miles southeast of La Fayette, the location of Purdue University Agricultural Experiment Station; 135 miles northeast of Evansville; 120 miles southwest of Fort Wayne; and 75 miles east of Terre Haute.

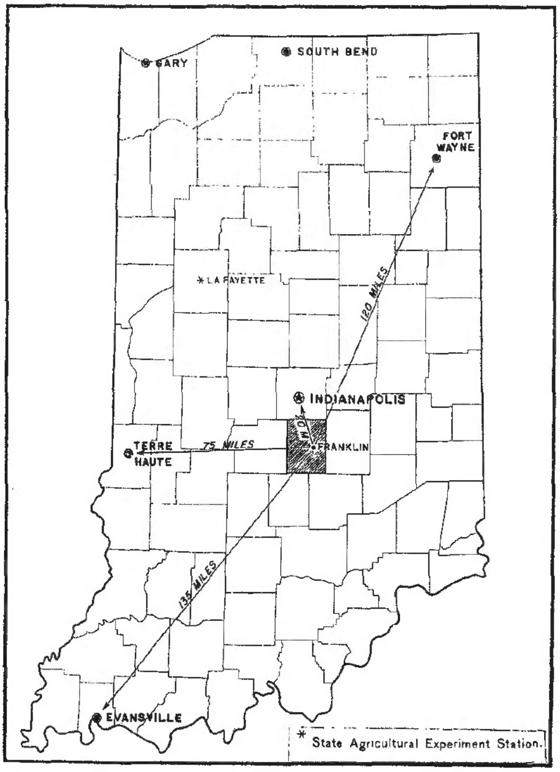


FIGURE 1.—Location of Johnson County in Indiana.

### PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The county lies within three distinct physiographic regions[2]—(1) Scottsburg Lowland, (2) Norman Upland, and (3) Tipton Till Plain. The physiographic regions, surface geology, and drainage system are shown in figure 2.

The southeastern part of the county is in the Scottsburg Lowland region and is characterized by great expanses of valley land along the streams and a notable lack of bluffs or steep slopes. It merges with the Tipton Till Plain to the north in the vicinity of Franklin. In this county the areas in the Scottsburg Lowland region include rather wide bottom-land

[2] LOGAN, W. N., CUMINGS, E. R., MALOTT, C. A., VISHER, S. S., TUCKER, W. M., and REEVES, J. R. HANDBOOK OF INDIANA GEOLOGY. Ind. Dept. Conserv. Pub. 21: 66–104, illus. 1922.

areas adjacent to the Blue and Driftwood Rivers, Sugar Creek, and their tributaries, and broad glaciofluvial outwash plains and terraces.

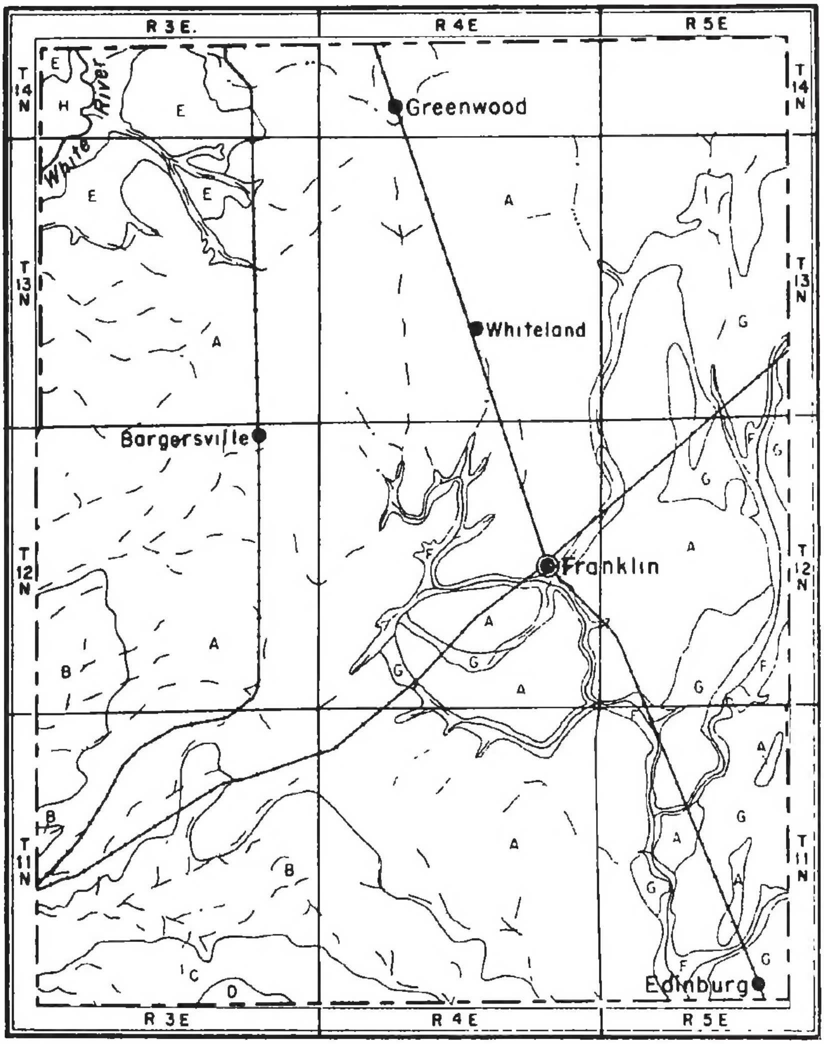


FIGURE 2.—Physiographic regions, surface geology, and drainage system of Johnson County, Ind.: *A*, *B*, *E*, *H*, Tipton Till Plain; *C*, *D*, Norman Upland; *F*, *G*, Scottsburg Lowland; *A*, Late Wisconsin glacial drift; *B*, Early Wisconsin glacial drift; *C*, Illinoian glacial drift; *D*, Borden sandstone, siltstone, and shale; *E*, *G*, glaciofluvial outwash of Wisconsin age; *F*, *H*, neutral to slightly alkaline alluvium from Wisconsin drift.

Only a small area in the southwestern part is in the Norman Upland region. Immediately west of the Scottsburg Lowland region, this body occurs as a bold escarpment rising more than 200 feet above the surrounding areas and appearing wall-like from a distance. The relief is characterized by long narrow ridges and deep V-shaped valleys. The bedrock,

composed of sandstone, siltstone, and shale of the Borden geologic formation (Lower Mississippian), outcrops on the ridge tops and slopes in a small area in the vicinity of and west of Peoga and along numerous slopes in the region of Illinoian glacial drift. The border zone includes deposits of Illinoian glacial drift. Here the drift deposits are several feet thick along the base of the upland, and in places thin deposits occur nearly to the higher ridge tops. The Illinoian glacial drift areas are highly dissected, but the ridges are in general flat-topped and show evidence of some modification by glacial action, although very little if any glacial drift occurs on the ridge tops.

The Tipton Till Plain region, which lies to the north of the Norman Upland and Scottsburg Lowland regions, includes more than three-fourths of the county. This is essentially a slightly modified ground-moraine plain, with several terminal moraines, knolls, and kames that rise several feet above the general level. Donnel Mound, about 3 miles northwest of Franklin, and Doty Mound, northwest of Bargersville, rise about 90 feet and 75 feet, respectively, above the adjacent till plain. The Shelbyville moraine occurs in the southwestern part, extending in a general east-west direction to the Scottsburg Lowland region The Champaign moraine extends in a northwest-southeast direction from a point just south of the northwestern corner of the county to the southeastern part The Bloomington moraine extends in an east-west direction across the northern part. These moraines are not conspicuous features of the topography and relief but are more or less disconnected areas rising several feet above the general level of the plain. They vary considerably in width, in places being several miles wide.

Two stages of the Wisconsin glaciation are included in the Tipton Till Plain—Early Wisconsin glacial period and Late Wisconsin glacial period. The Early Wisconsin glaciation occurs in the southwestern part of the county, north of the Norman Upland region. There is, in general, more dissection and greater relief than in the Late Wisconsin drift area, but the relief of the broader interstream areas is that of an undulating till plain. The drift material is similar in composition to the Late Wisconsin drift, but because of its greater age, leaching and weathering are more pronounced and the average depth to free lime carbonates is about 45 inches. The Late Wisconsin glaciation, occupying the rest of the Tipton Till Plain region, is a constructional plain only slightly modified by stream dissection. The stream valleys are shallow, and in many places dissection has not penetrated into the broad interstream areas; thus numerous areas remain naturally poorly drained. The average depth to free lime carbonates is about 36 inches.

The maximum altitude of the county is about 930 feet above sea level on the high ridge west of Peoga, the minimum about 610 feet in the southeastern part. The maximum relief is 320 feet and the maximum local relief 225 feet, the latter occurring in the southwestern part. The elevation at Edinburg (railroad station) is 673 feet and at Franklin 740 feet.

The county is drained by two major drainage systems within the State—the East Fork and the West Fork of the White River. A line drawn from just east of Greenwood to Bargersville and south to a point slightly east of Peoga divides the county into the two drainage areas. Most of the area lying to the east is drained by Sugar and Youngs Creeks and their tributaries, which unite with the Blue River at Edinburg to form the Driftwood River, which in turn unites with Flatrock Creek at

Columbus, Bartholomew County, to form the East Fork White River. The southern part of Nineveh Township is drained by small tributaries that flow into the Driftwood River in Bartholomew County. The area lying to the west drains into the West Fork White River, which flows through the extreme northwestern part of the county. Stream dissection is more complete in the western and southwestern parts.

## CLIMATE

The climate of the county is continental, humid, and temperate, with warm humid summers and moderately cold winters and is characterized by sudden changes in temperature. The type of agriculture practiced is in general adjusted to the prevailing climatic conditions and with few exceptions the crops grown are adapted to the climate. Over a period of years the growing season is sufficient for the maturing of most farm crops.

Detailed climatic data fairly representative of climatic conditions in Johnson County are given in table 1; these are compiled from records of the United States Weather Bureau station at Indianapolis in Marion County. Indianapolis is only about 10 miles north of the county line and has an elevation of 718 feet, compared with 740 feet at Franklin.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation in Marion County, Ind.* [1]

[Indianapolis, elevation, 718 feet]

| Month | Temperature | | | Precipitation | | | |
|---|---|---|---|---|---|---|---|
| | Mean | Absolute maximum | Absolute minimum | Mean | Total for the driest year | Total for the wettest year | Average snowfall |
| | °F | °F | °F | Inches | Inches | Inches | Inches |
| December | 32.2 | 68 | −15 | 2.98 | 1.87 | 0.90 | 5.1 |
| January | 28.4 | 70 | −25 | 2.95 | 1.25 | 5.94 | 6.8 |
| February | 31.1 | 72 | −18 | 2.73 | .86 | 4.58 | 5.3 |
| Winter | 30.6 | 72 | −25 | 8.66 | 3.98 | 11.42 | 17.2 |
| March | 40.0 | 84 | 0 | 3.93 | 3.32 | 7.44 | 3.8 |
| April | 52.1 | 90 | 19 | 3.62 | 2.23 | 2.27 | .9 |
| May | 62.0 | 96 | 31 | 3.89 | .60 | 5.11 | .1 |
| Spring | 51.7 | 96 | 0 | 11.44 | 6.15 | 14.82 | 4.8 |
| June | 71.6 | 100 | 39 | 3.62 | 2.98 | 7.54 | 0 |
| July | 75.7 | 106 | 48 | 3.34 | 2.50 | 7.48 | 0 |
| August | 73.7 | 103 | 41 | 3.31 | 2.49 | 5.86 | 0 |
| Summer | 73.7 | 106 | 39 | 10.27 | 7.97 | 20.88 | 0 |
| September | 66.9 | 98 | 30 | 3.40 | 4.54 | 3.85 | 0 |
| October | 55.7 | 89 | 22 | 2.78 | .19 | 4.42 | (2) |
| November | 42.3 | 76 | −5 | 3.35 | 2.14 | 2.26 | 1.2 |
| Fall | 55.0 | 98 | −5 | 9.53 | 6.87 | 10.53 | 1.2 |
| Year | 52.7 | [3] 106 | [4] −25 | 39.90 | [5] 24.97 | [6] 57.65 | 23.2 |

[1] From U. S. Weather Bureau records
[2] Trace.
[3] July 1936
[4] Jan 1884
[5] In 1934
[6] In 1876.

The mean winter temperature is 30.6° F. There are, however, wide variations from a minimum of −25° to a maximum of 72°. These variations are often rather sudden and accompanied by alternate freezing and thawing, which causes considerable damage to fall-sown small grains,

alfalfa, and clovers, especially when severe cold occurs without a protective snow cover. When protected by snow, wheat will withstand extremely low temperatures, but probably the greatest injury results from the occurrence of low temperatures when the soil is saturated, as this causes a coating of ice to form over the plants. The frequency of this damage, however, is not sufficient to discourage the growing of these crops.

The mean temperature for the summer months is 73.7°. This varies from a maximum of 106° to a minimum of 39°. The general farm crops are not often affected by these extremes, unless the high temperatures occur during periods of drought.

The average frost-free season, as recorded by the United States Weather Bureau station at Indianapolis, is 188 days, from April 15 to October 20. This is usually ample for the growing and maturing of most farm crops. Some crops, however, are injured by late spring or early fall frosts. Although injury to corn by late spring frosts is uncommon, tomatoes, vegetables, strawberries, apples, and peaches occasionally are damaged. When seasonal conditions delay the planting of corn and soybeans or excessive moisture in fall prevents their maturing, injury may result from early frosts. Killing frost has occurred as late as May 25, and as early as September 21. When these extremes occur general crop damage usually is severe.

The mean annual precipitation is 39.90 inches. The total rainfall in the driest year was 24.97 inches and in the wettest year 57.65 inches. The mean precipitation for the growing season—April to September, inclusive—is 21.18 inches, or about 53 percent of the total annual precipitation. The average annual snowfall is 23.2 inches, with 17.2 inches, or about 74 percent, occurring in December, January, and February.

Much of the rainfall during spring and summer is associated with cyclonic storms, with uneven distribution over the county. Low precipitation during summer results in crop injury, especially when associated with high temperatures and strong winds. Hailstorms are not common, but when they do occur damage to crops may be severe.

Excessive rainfall in early fall retards the maturing of corn, soybeans, and other crops and may lower the quality of tomatoes. Hot dry weather in fall delays the sowing of small grains and may reduce corn and tomato yields.

Much of the precipitation during winter occurs as snow, but when it occurs as rain the runoff is usually rapid and results in serious erosion on the steeper slopes. Snow and gentle winter rains are desirable, as they build up available moisture in the soil as a reserve for spring-planted crops.

## WATER SUPPLY

Water supplies for both people and livestock are obtained from wells drilled into the unconsolidated subsoil material or into the underlying bedrock. In the stream valleys the driven wells are 15 to 25 feet deep, whereas in the upland till plains they range from 25 to 100 feet or more, depending upon the presence of sand or gravel strata. Springs frequently occur on hillsides where sand and gravel strata outcrop. The water supply is less certain on the sandstone, siltstone, and shale upland in the southwestern part of the county. Water obtained from wells drilled into the sandstone, siltstone, and shale bedrock often is high in mineral con-

tent and has a disagreeable odor. The various rivers and streams also are a source of water supply for livestock.

## VEGETATION

Except for a few scattered muck areas and some poorly drained places, the entire county originally was covered by an excellent stand of mixed hardwoods. The principal species on the well-drained upland areas included white oak (*Quercus alba* L.), black oak (*Q. velutina* Lam.), Southern red oak (*Q. rubra* L.), American elm (*Ulmus americana* L.), yellow-poplar (tuliptree) (*Liriodendron tulipifera* L.), and sugar maple (*Acer saccharinum* L.). The poorly drained areas in the Wisconsin drift region had a predominance of beech (*Fagus grandifolia* Ehrh.), maple, ash (*Fraxinus* sp.), and elm. The bottoms sustained a growth of cottonwood (*Populus deltoides* Marsh.), ash or linn basswood (*Tilia americana* L.), European white willow (*Salix alba* L.). and sycamore (buttonwood) (*Platanus occidentalis* L.).

Species in areas now forested are practically all reproductions of the original stand. A large part of these areas has an understory of blackberry (*Rubus* sp.), wild rose (*Rosa* sp.), and black locust (*Robinia pseudoacacia* L.), with persimmon (*Diospyros virginiana* L.), sassafras (*Sassafras albidum* (Nutt.) Nees), and sumac (*Rhus* sp.) also present in the regions of Illinoian drift and Borden sandstone, siltstone, and shale.

With the exception of scattered areas of woodland, most of the land has been cleared of forest. The most extensive forest areas are on the steeper slopes in the southwestern part, on areas of Illinoian drift and Borden sandstone, siltstone, and shale. Very little merchantable timber remains, and in most areas the trees are cut for railroad cross ties as soon as they reach the required size—12 to 18 inches in diameter. Most of the woodland in the regions of Wisconsin drift is pastured, which prevents regeneration. In the southwestern part of the county, however, there is a trend at present toward conversion of cropland and idle pasture land to forests, especially on sloping areas susceptible to erosion.

## ORGANIZATION AND POPULATION

Johnson County was created by an act of the legislature on December 31, 1822,[3] from what was originally a part of the territory belonging to the Delaware Indians and was named in honor of John Johnson, a former judge of the Supreme Court. Indian claims were extinguished by the treaty of October 1818, and few Indians remained after white settlement began in 1820. John Campbell, reported to have been the first settler, located on the Blue River near the site of Edinburg, and when the land sales began on October 2, 1820, he, with 8 other men, entered land in the county. Settlement proceeded rapidly, and by 1880 the population had increased to 19,537, about 84 percent of which was rural. In 1940 the population was 22,493, of which 16,229 (72.2 percent) was rural. It is largely native-born whites, many of the original settlers having come from Kentucky, Ohio, Pennsylvania, North Carolina, Virginia, and Tennessee.

Franklin, the county seat, was laid out in 1823. It is a thriving town with a population of 6,264 (1940 census). A large number of smaller towns throughout the county are accessible trading centers, the more

[3] BANTA, D. D. HISTORY OF JOHNSON COUNTY. 918 pp., illus. 1888.

important of which are Greenwood, population 2,499; Edinburg, 2,466; Trafalgar, 500; Whiteland, 403; Bargersville, 297; and Nineveh, 225

### INDUSTRIES

Johnson County is well provided with industries engaged in the processing of agricultural products, including dairy products, grain, and vegetables. Whole sweet milk and, to a limited extent, sweet and sour cream, are delivered to the plants and made into cheese, butter, and other dairy products. Grain, including wheat, corn, and oats, is made into flour, corn meal, and other products for human consumption or ground and mixed for livestock. Vegetables are processed and canned in factories at Franklin, Greenwood, Bargersville, Trafalgar, Edinburg, and Whiteland. These industries have a decided influence on the agriculture of the county, being responsible for the large vegetable acreage, especially of tomatoes and sweet corn.

Household furniture, office furniture and filing equipment, underwear, and millwork are manufactured at Franklin; auto accessories at Greenwood; and veneer sewing machine cabinets at Edinburg. All the factories are small, and the total number of people employed is not large.

### TRANSPORTATION AND MARKETS

Three railroads serve the county—the Pennsylvania, the Illinois Central, and the Cleveland, Cincinnati, Chicago, and St. Louis. The building of these systems about 1850 was an important factor in the agricultural development of the county. Thereafter most of the livestock, livestock products, and grain was transported to markets by rail until the advent of motortrucks and hard-surfaced roads. Now practically all these products are transported to market by motortruck, and the increased acreage in vegetables has been encouraged by the availability of truck transportation.

A network of hard-surfaced highways—United States Highway No. 31 and 5 state highways—traverse the county. County roads are in good to excellent condition, except in the southwestern part, where they are fair. The 1940 Federal census reports 611 farms on hard-surfaced roads; 1,311 on gravel, shell, or shale roads; only 6 on improved dirt roads; and only 3 on unimproved dirt roads. Excellent bus service on the major highways, especially United States Highway No. 31, has partly contributed to a change in the shopping habits of people living along the routes.

### CULTURAL DEVELOPMENT AND IMPROVEMENT

The school system of Johnson County is largely consolidated. Numerous churches serve the needs of the communities. Free mail delivery service is available to all districts, and telephone service is readily available in all but the southwestern part, where it is somewhat limited. The 1940 census reports 737 farms served by telephone. Electric service is available to a large part of the county. In 1940, 1,424 of 1,749 farm dwellings reported within one-fourth mile of distribution lines were served by electricity from these power lines, and 73 farms had home plants.

## AGRICULTURE

Agriculture in Johnson County began about 1820 with the advent of the first few white settlers and the departure of the Indians. The first

settlements were principally along the larger streams and on the well-drained upland areas. Gradually the land was cleared of heavy timber, artificial drainage was installed in poorly drained areas, and a large part of the land was cultivated for agriculture. During the early period of development the lumber industry was about as important as farming.

Agriculture then as now was centered around the three main crops—corn, wheat, and hay. Through lack of adequate transportation facilities and markets, agricultural development was retarded in the early period. The advent of the railroads, however, opened up new markets, greatly stimulated the development of agriculture, and encouraged a more diversified system of farming, which included the growing of more cash crops and the raising of more livestock. The use of motortrucks on hard-surfaced highways and good gravel roads further stimulated agriculture and caused greater specialization in dairying, in livestock and poultry raising, and in the production of vegetable and other farm crops and products.

## CROPS

The acreage of the principal crops and the value of agricultural products by classes, as reported by the United States census, are given in tables 2 and 3.

TABLE 2.—*Acreage of the principal crops and the number of bearing apple trees in Johnson County, Ind., in stated years*

| Crop | 1879 | 1889 | 1899 | 1909 | 1919 | 1929 | 1939 |
|---|---|---|---|---|---|---|---|
| | *Acres* | *Acres* | *Acres* | *Acres* | *Acres* | *Acres* | *Acres* |
| Corn | | | | | | | |
| For grain | 51,743 | 44,079 | 51,263 | 58,615 | 52,373 | 45,518 | 44,525 |
| For silage | | | | | | 2,598 | 1,137 |
| Hogged, grazed, or cut for fodder | | | | | [1] 17,485 | 3,167 | 718 |
| Oats | | | | | | | |
| Threshed | 1,834 | 5,077 | 1,485 | 3,480 | 3,319 | 5,940 | 3,113 |
| Cut and fed unthreshed | | | | | | 1,733 | 490 |
| Wheat | 35,052 | 36,009 | 39,892 | 38,862 | 48,979 | 31,399 | 25,141 |
| Rye | 95 | 62 | 16 | 92 | 347 | 1,552 | 676 |
| Barley | 30 | 6 | | | 9 | 53 | 76 |
| All hay | 9,432 | 17,752 | 20,550 | 20,956 | 19,249 | 20,882 | 19,787 |
| Timothy and clover, alone or mixed | | | | 9,948 | 12,381 | 11,380 | 8,777 |
| Clover alone | | | 13,292 | 10,275 | 5,842 | 6,493 | [2] 119 |
| Alfalfa | | | 53 | 92 | 275 | 716 | 3,382 |
| Annual legume hay | | | | | 6 | 1,924 | 5,802 |
| Small grain hay | | | 359 | 477 | 719 | 195 | 1,573 |
| Other tame hay | | | 6,846 | 164 | 26 | 174 | 134 |
| Soybeans | | | | | | 2,091 | 8,954 |
| Potatoes | | 615 | 314 | 339 | 131 | 123 | 54 |
| Sweetpotatoes and yams | 10 | 19 | 16 | | | 15 | 7 |
| Market garden vegetables | | | | | 1,205 | 5,463 | 8,771 |
| Sweet corn | | | | | 551 | 2,087 | 2,974 |
| Tomatoes | | | | | 432 | 3,008 | 4,355 |
| Tobacco | 5 | 10 | 26 | 35 | 8 | 50 | 18 |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| Apples ... trees | | 40,471 | 66,074 | 50,379 | 41,444 | 26,220 | 15,654 |

[1] Cut for forage [2] Sweetclover only

The acreage in cereal crops reached its peak in 1919, when corn, oats, wheat, rye, and barley were grown on 105,027 acres. This was 31,496 acres more than in 1939.

Corn is the most important crop, both in total acreage and value. It is the basic feed crop in the prevailing livestock system of farming, and its dominant position is due largely to its special adaptation to the soils.

TABLE 3.—*Value of specified agricultural products in Johnson County, Ind., in 1929 and 1939*

| Crops | 1929 | 1939 | Livestock products | 1929 | 1939 |
|---|---|---|---|---|---|
| Cereals | $1,882,095 | $1,601,875 | Dairy products sold | $697,548 | $569,664 |
| Corn harvested for grain | 1,161,430 | 1,255,752 | Whole milk | 636,668 | 529,441 |
| Wheat threshed | 650,450 | 317,349 | Cream [1] | 53,766 | 37,984 |
| Other cereals | 70,215 | 28,774 | Butter | 7,114 | 2,239 |
| Other grains and seeds | 39,162 | 65,033 | Poultry raised and chicken eggs produced | 596,119 | 246,816 |
| Hay and forage | 416,562 | 347,980 | Poultry | 332,017 | 160,765 |
| Tobacco | 6,464 | 3,972 | Chicken eggs | 264,102 | 86,051 |
| All vegetables (excluding potatoes and sweetpotatoes) | 365,817 | 375,155 | Livestock sold or slaughtered | (2) | 1,672,639 |
| For sale | 277,913 | 307,994 | Cattle and calves | (2) | 674,107 |
| For home use | 87,904 | 67,161 | Hogs and pigs | (2) | 943,166 |
| Potatoes and sweetpotatoes | 16,671 | 3,972 | Sheep and lambs | (2) | 55,366 |
| Fruits and nuts | 63,312 | 46,116 | Wool shorn | 13,200 | 9,634 |
| Horticultural specialties sold | 18,374 | 15,210 | Honey produced | 5,595 | 1,264 |
| All other crops | 4,685 | 1,337 | | | |
| Forest products sold | 6,430 | 1,738 | | | |

[1] Both sweet cream and sour cream (butterfat)
[2] Not available

The total acreage in corn for grain decreased from a high of 58,615 acres in 1909 to 44,525 acres in 1939. The decrease in recent years has been due largely to the rapid increase in the acreage of soybeans and vegetables. The average yield increased from about 36 bushels an acre in 1929 to 56 bushels in 1939. Whereas this difference may be due in part to variations in seasonal conditions, the increased use of hybrid seed corn since its introduction has probably been responsible for the general increase in average yields. The larger acreage and higher yields are on areas of Late Wisconsin and Early Wisconsin drift soils where there is a dominance of the dark-colored Brookston soils (see fig. 3, p.26); on the dark-colored Westland, Abington and Mahalasville soils of the glaciofluvial outwash plains and terraces; and the Genesee and Eel soils of the first bottoms.

Land to be used for corn is plowed either in fall or early spring, depending on weather conditions and soil type. Fall plowing encourages erosion, especially on the more rolling areas, and consequently the greater part of cornland on the rolling areas is plowed in spring. The ground is thoroughly disked and smoothed with either a harrow or cultipacker before planting. For plowing and preparing the seedbed, most farmers use modern machinery, and some use 2- or 4-row corn planters powered by tractors. Corn is planted in May—in normal seasons from May 10 to May 20. There has long been an interest in the county in improved varieties of seed corn, and before the introduction of hybrid seed, Reid Yellow Dent and Johnson County White were the popular varieties, the latter being developed in this county. Probably more than 90 percent of the seed corn planted now is hybrid.

There has been a steady increase in the fertilization of corn in recent years. The more popular analyses are 2–12–6,[4] 0–10–10, or 0–12–12, with the rate of application ranging from 65 to 150 pounds or more an acre. Application generally is made either in the row or the hill at the time of planting, depending upon whether the corn is planted in drilled rows or in hills.

Methods of harvesting corn vary with the individual farm requirements. It may be husked in the field, cut for silage, cut and shocked

[4] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

in the field, or hogged off. At present most of it is harvested in the field with mechanical pickers. Most of the corn grown is fed to livestock on the farm, with a small percentage in years of abnormally high yields sold to livestock feeders in adjacent areas.

Wheat is second in total acreage and the most important cash crop. The acreage in 1939 (25,141 acres) was only slightly more than half that in 1919. This sharp reduction is due partly to the crop reduction program and partly to the increased acreage used for soybeans and vegetables.

Wheat may follow corn, soybeans, or oats in the rotation system, and may be sown on land where legumes have failed. When following corn, the wheat is drilled between the corn rows or after the corn has been cut for silage or fodder. In the latter case the land is disked, and smoothed with a drag or harrow before the seed is planted. When wheat follows soybeans it generally is drilled without any previous working of the soil; following other crops the seedbed is prepared by plowing and disking. Seeding takes place in September, or in some instances early October, usually after the fly-free date (date at which the hessian fly ceases to be a danger) as given by the Purdue University Agricultural Experiment Station. The general practice is to drill fertilizer (usually 2–12–6) with wheat at the time of seeding, the rate ranging from 100 to 300 pounds an acre. Top dressing with barnyard manure in winter or early spring is not a general practice, and may vary from year to year.

Wheat ripens in the latter part of June or early in July. It is either cut with a grain binder and placed in shocks to be threshed later, or cut and threshed with the combine. It is marketed largely through local elevators as a cash crop. Relatively small quantities are retained on the farm for seed, and in years of reduced supply of other feeds it is ground and fed to hogs, dairy cows, and other livestock. The varieties grown include Fultz, Trumbull, Michigan, Amber, Rudy, Gladden, and Purdue No. 1. Fairfield, a variety recently developed at Purdue University Agricultural Experiment Station, is highly resistant to winter-killing, and the quality and yield are better than in most other varieties. In a few years it is expected to replace many of the present varieties.

Although wheat is grown throughout the county, it is better adapted to the soils of the Wisconsin drift and glaciofluvial outwash plain and terrace areas. When grown on the dark-colored soils of these areas, as the Brookston, Clyde, Westland, Abington, and Mahalasville, there is danger of a too heavy growth of straw and improper ripening of the grain unless larger quantities of phosphate fertilizer are used. Wheat will tolerate a rather high acidity, and good yields can be obtained on areas of Illinoian drift and Borden sandstone, siltstone, and shale soils if a proper fertilization program is followed. Imperfect drainage conditions are injurious to wheat, and yields may be substantially reduced by heaving or drowning out.

Rye always has been a minor grain crop, with great fluctuation in acreage. In 1929, 1,552 acres were harvested contrasted with only 676 acres in 1939. Methods of seeding and harvesting are essentially the same as for wheat, although rye usually is seeded somewhat earlier in fall and very little if any fertilizer used. It is often pastured for a few weeks in spring before other pasture is available. The grain generally is ground and used as feed for hogs and other livestock on the farm.

Oats follow corn, wheat, or soybeans in the rotation, or they may be sown where alfalfa or other legumes have been winter killed. They are

seeded in March or early April, depending upon weather conditions. Yields are in general larger when seeding is early, but are materially reduced by prolonged hot, dry weather during any part of the growing and ripening season. When oats follow corn, wheat, or soybeans the land is disked, or in some instances plowed, and the seed is either drilled or sown broadcast and disked in. When they follow legumes the land is plowed before seeding. Harvesting takes place late in July or in August, the methods being similar to those for wheat. Oats are either marketed through elevators or retained on the farm and used as livestock feed. In years of reduced feed supplies a large part of the crop is ground and mixed with other feeds for use on the farm.

The acreage of soybeans has increased very rapidly in recent years, both for hay and for seed. In 1939, 8,954 acres were planted, of which 2,990 were harvested for beans. The increasing demand for soybeans as a source of oil and the attractive price of the beans are largely responsible for the greater acreage.

Soybeans, following corn, wheat, or oats in the rotation, are planted late in May or in June; they are seeded also on land where legumes have been winter killed. A seedbed is prepared as for corn, and thorough weed control both before and after planting is essential for successful growth. Seed should be inoculated until the soil in the producing field carries abundant inoculation. For maximum feeding value of the hay, the seed should be well developed in the pod before harvest. Harvesting for seed is accomplished almost entirely with combines. Most of the seed is marketed through elevators as a cash crop, although some is retained on the farm for seed and for livestock feed.

Other cereal and grain crops grown to a limited extent include barley, buckwheat, sorghum, and cowpeas. Usually they do not have a place in the crop rotation systems but are grown as emergency crops on areas where some other crop has failed. Barley and buckwheat usually are limited to the southwestern part; sorghums are grown for silage, hay, or fodder, and for molasses in various parts; and cowpeas are grown occasionally for both hay and seed.

The acreage in hay crops during the last 50 years has been rather uniform, but a great change has occurred in the kinds grown. Both timothy alone and clover alone have given way to alfalfa, annual legumes, small grain hay, sweetclover, lespedeza, and other less important hay crops.

The very rapid increase in the acreage of alfalfa, as shown in table 2, has resulted from a more general knowledge that liming of most of the soils is a necessary prerequisite to successful growth of alfalfa and from appreciation of its feeding qualities both as pasture and as hay. It is either seeded in fall, with or without a nurse crop, or seeded in wheat or with oats in spring. When seeding in fall a good seedbed is prepared, and the soil is packed with a cultipacker or roller to maintain good moisture conditions. As most of the soils need to be limed for success with alfalfa, a majority of farmers do not attempt to grow it until sufficient lime, usually in the form of ground limestone, is applied to bring the reaction of the soil to pH 6.0[6] or higher.

Alfalfa is not adapted to the acid soils of the Illinoian drift and the the Borden sandstone, siltstone, and shale regions, and little success is obtained when attempts are made to grow it in these areas. It is well adapted to the soils of the Wisconsin glacial drift region after sufficient

[6] See footnote 7, p. 21.

liming and to the sweet alluvial soils. Inoculation of the seed is essential for most successful growth and for the storage of nitrogen on the roots of the plants. Alfalfa is used for both pasture and hay, depending largely on the type and number of livestock on the farm. The varieties adapted to this area include North Dakota and South Dakota common, Kansas common, Grimm, and Montana common.

Sweetclover is grown primarily as a soil improvement crop, but it may be used also as pasture or grown for seed. Like alfalfa, it requires a soil with a reaction of pH 6.0 or higher for successful growth, and inoculation of the seed is essential both to insure proper growth and to enable the plants to store nitrogen in the soil. Most of the sweetclover is seeded in wheat or with oats in spring. Occasionally it is sown as a part of a mixed pasture, including alfalfa, clover, timothy, and occasionally bromegrass. In some areas it is used as an intercrop in a 2-year rotation of wheat and corn or oats and corn.

The acreage of clover alone, including both common red and mammoth red, has decreased greatly since 1899. This may be due to the increase in alfalfa acreage and to the more general practice of using clover as part of a mixture that also includes alfalfa, timothy, alsike clover, sweetclover, and in some instances, bromegrass. Clover is seeded in spring, in wheat or rye, or with oats. It will tolerate a higher acidity than either alfalfa or sweetclover, but for best results it is necessary that sufficient lime be applied to the soil to lower the acidity to about pH 6.0. Inoculation of clover seed is necessary to insure proper growth and to enable the plants to store nitrogen in the soil.

Clover is used for both pasture and hay. It may be pastured in the early part of the season and then cut for hay. The first cutting of common red clover often is used for hay and the cutting in fall is for seed. Hay yields ½ to 2 tons an acre, and seed yields ½ to 1½ bushels. Practically all the hay is used on the farm, although in years of large yield a small part may be sold to livestock farmers in adjacent areas.

The acreage used for timothy alone has steadily decreased in recent years. Timothy is largely replaced by alfalfa, clovers, and other legumes in the rotation or is grown as a part of a mixed seeding. Because of its tolerance of strong acidity, it can be successfully grown on areas of Illinoian drift and Borden sandstone, siltstone, and shale soils in the southwestern part.

Hay crops grown to a limited extent include lespedeza, bromegrass, millet, rape, and sudan grass. Lespedeza is well adapted to the acid soils in the southwestern part, including the regions of Illinoian drift and Borden sandstone, siltstone, and shale. Although there has been some interest in this crop in these areas, no doubt more lespedeza should be grown there. Bromegrass has been used to a limited extent with alfalfa and other legumes, usually taking the place of timothy in the mixture. Recent experiments by the Purdue University Agricultural Experiment Station show that it is equal to or superior to timothy as pasture for cattle and hogs, and its use probably will be increased in future years. Millet, rape, and sudan grass are grown to a limited extent, usually as special pasture to supplement other pastures or as emergency pasture when other pastures have failed.

Vegetable growing occupies an important place in the farming system of the county. A total of 8,771 acres of vegetables was harvested for sale in 1939, the largest acreage being in sweet corn and tomatoes. The location of canning factories in numerous towns throughout the county

and the close proximity of Indianapolis markets are responsible for this large acreage. Sweet corn is grown principally in the Wisconsin drift region and on alluvial areas; soil and fertilization requirements and planting methods are about the same as for field corn. Occasionally it is planted where canning peas have been grown and harvested. Tomatoes are better adapted to the Brookston and Crosby soils of the Late Wisconsin drift region, and the greater part of the acreage is on areas of these soils. Yields generally are higher on the dark-colored Brookston soils, but the quality generally is better on Crosby soils. The common practice is to fertilize tomatoes with 150 to 300 pounds an acre of a 2–12–6 mixture.

Green peas are grown both for canning factories and the Indianapolis market. There were 452 acres grown in 1939, principally on the well-drained soils of the glaciofluvial outwash plains and terraces. Peas are planted as early as possible in spring and generally are followed by sweet corn. Pumpkins were grown for sale on 416 acres in 1939, most of them going to local canning factories. Green lima beans, grown for canning factories and local and Indianapolis markets, were harvested on 393 acres in 1939. Other vegetables grown to a limited extent include snap beans, cabbage, peppers, watermelons, and cucumbers, the greater part of which was marketed at Indianapolis or local roadside markets.

## ROTATIONS AND FERTILIZERS

The following crop rotations are commonly used in the regions of Early Wisconsin and Late Wisconsin drift: (1) Corn, wheat or oats, legumes, including clover, alfalfa, sweetclover, or a mixture of these with timothy and bromegrass; (2) corn, wheat or oats, 2 years of alfalfa; and (3) corn, soybeans, wheat, mixed legumes and grasses. These rotations are varied to include special field and vegetable crops, and the order in the rotation occasionally is changed to meet special seasonal and feed requirements. A rotation of wheat or oats, intercrop of sweetclover, and corn sometimes is used on the more productive areas.

Rotations in common use on the glaciofluvial outwash plain and terrace areas are corn, wheat, 1 or more years alfalfa; or corn, soybeans, wheat, mixed hay. These are varied to include vegetables and to meet seasonal requirements.

On the sweet alluvial soils rotations generally include corn 2 or more years, wheat, corn; or corn, wheat, and alfalfa or mixed hay. An occasional special crop, as sweet corn, is grown, and in recent years an increasing quantity of soybeans is grown, generally following corn in the rotation.

In the regions of the Illinoian drift and Borden sandstone, siltstone, and shale, in the southwestern part of the county, rotations include corn, wheat, and either timothy or lespedeza, or a mixture of timothy and clover. This is varied to include soybeans and some vegetable crops, and occasionally oats, barley, and other field crops.

The use of commercial fertilizer is general, and in 1939, 66.3 percent (1,289) of the farms reported an expenditure of $117,864, or an average of $91.44 each. This was slightly less than in 1929 when 1,225 farms, or 65.3 percent, reported an expenditure of $137,198 ($112 per farm). Fertilizer is largely purchased ready-mixed, but a small number of farmers do home mixing. It is purchased both individually and cooperatively, an increasing quantity through cooperative farm organizations. The present trend is toward the use of higher analysis fertilizers and in larger

quantities an acre. The common practice is to fertilize wheat, corn, and vegetables, and the trend is toward direct fertilization of soybeans, both by plowing under the fertilizer and by applying it at time of planting. There is also a trend toward indirect fertilization of soybeans and legumes by applying larger quantities with wheat, oats, and other small grains. It is common practice to supplement commercial fertilizer with barnyard manure. Most of this is applied to land that is to be plowed for corn, but some is used as a top dressing for wheat.

The value of lime for correcting soil acidity is generally recognized, and an increasing quantity, principally in the form of ground limestone, has been used in recent years. To determine the lime requirements of a soil or soils in a given field, it is important that an accurate test be made. This can be accomplished with a number of available acidity indicators. Probably the best procedure is to take samples of the different soils in an area, both surface soil and subsoil, and mail or take them to the county agricultural agent at Franklin, or mail them to the Purdue University Agricultural Experiment Station, La Fayette, Ind.

## PERMANENT PASTURES

The permanent pastures in the Wisconsin drift regions, including the glaciofluvial outwash plains and terraces and alluvial areas, are principally Kentucky bluegrass in relatively small fields on a large number of farms. The imperfectly drained soils of the bottoms probably have a larger percentage in permanent pasture than any other soil group in these areas. Fertilization of these pastures is not a common practice, although most of them could be improved by the use of fertilizers and a pasture-improvement program. In areas of Illinoian drift and Borden sandstone, siltstone, and shale, the permanent pastures are generally of inferior quality. Some have a good stand of Kentucky bluegrass, but a large number consist largely of broomsedge. In these areas a pasture-improvement program that includes the use of sufficient lime and fertilizer is essential to maintaining adequate pasture.

## LIVESTOCK AND LIVESTOCK PRODUCTS

The raising of livestock has been a very important source of farm income for the last 60 years, and is the medium through which a large part of the farm crops are marketed. The number and value of livestock on farms, as reported by the United States census in 1920, 1930 and 1940, are given in table 4, and the value of farm products sold or traded by farm households, in 1939 by source of income, are shown below:

| Agricultural product: | *1939* |
|---|---|
| Livestock and livestock products sold or traded | $2, 298, 384 |
| Livestock [1] | 1, 639, 975 |
| Dairy products | 516, 620 |
| Poultry and poultry products | 130, 028 |
| Other livestock products | 11, 761 |
| Crops sold or traded | 1, 108, 974 |
| Field crops [2] | 747, 014 |
| Vegetables harvested for sale | 306, 705 |
| Fruits and nuts | 40, 095 |
| Horticultural specialties sold | 15, 160 |
| Forest products sold | 1, 738 |
| Total cash farm income | 3, 409, 096 |

[1] Excludes poultry, bees, and fur-bearing animals
[2] Includes value of potatoes and sweetpotatoes.

TABLE 4.—*Number and value of livestock on farms in Johnson County, Ind., in stated years*

| Livestock | 1920 | | 1930 | | 1940 | |
|---|---|---|---|---|---|---|
| | *Number* | *Value* | *Number* | *Value* | *Number* | *Value* |
| Horses | 8,529 | $860,505 | 5,360 | $394,288 | [1] 4,098 | $323,506 |
| Mules | 1,777 | 207,450 | 628 | 54,308 | [1] 504 | 41,628 |
| Cattle | 17,548 | 1,260,287 | 17,481 | 896,043 | [1] 19,508 | 862,360 |
| Swine | 55,187 | 982,126 | 47,968 | 487,320 | [2] 36,012 | 348,708 |
| Sheep | 4,999 | 63,870 | 11,769 | 90,394 | [3] 6,345 | 39,045 |
| Goats | 85 | 259 | 59 | 195 | [2] 38 | 87 |
| All poultry | 171,473 | 175,399 | (4) | (4) | [2] 99,688 | 53,798 |
| Chickens | 169,322 | (4) | [1] 127,299 | 113,296 | [2] 98,619 | 52,268 |
| Bees ... hives | 429 | 1,774 | 1,092 | 4,423 | 410 | 984 |

[1] Over 3 months old, April 1.
[2] Over 4 months old, April 1.
[3] Over 6 months old, April 1.
[4] Not reported.

On April 1, 1940, there were 19,508 cattle over 3 months old on farms, which was a slight increase from 17,481 in 1930. There were 8,422 cows kept mainly for milk production, and 1,380 cows kept mainly for beef production in 1940. In 1939, 8, 451 cattle and 6,132 calves were bought and 9,671 cattle and 7,099 calves sold.

Dairying is one of the more important branches of the livestock industry in the county. Two types are followed— specialized dairying and general dairying.

Specialized dairies are in the vicinity of the larger towns, and in the northern part, which is close to the Indianapolis market. These dairies are maintained for the production and sale of whole sweet milk, sweet cream, butter, and other dairy products to the nearby cities, including Indianapolis. Most of the sweet milk and cream is bottled and sold, both retail and wholesale. High-producing breeds, mainly purebred Holstein-Friesians and Guernseys, are used, with a few herds of purebred Jerseys and high-grade mixed breeds.

General dairying includes farms that market their products through creameries, largely as whole sweet milk or as sweet cream. Trucks call at the farms daily for these products and deliver them to the creameries in this and neighboring counties. A few herds are purebred Holstein-Friesian, Guernsey, and Jersey breeds, but the greater number consists of good grade cows.

Dairy products provided the major source of income in 1939 on 263 farms, or about 13 percent of the total. The larger part of the feed—corn, oats, and hay—for dairy cattle is grown on the farm. A large quantity of commercial supplements is used, however, especially by the larger dairies.

The beef cattle industry is less specialized than dairying, and there is a general distribution of beef cattle, with the probable exception of the southwestern part. A large part of the cattle bought in 1939 was purchased as feeder cattle. Most of the cattle are purchased when small, grazed during summer, and "finished" on corn, hay, and commercial supplement feeds. They are marketed primarily at Indianapolis.

Johnson County is almost entirely within the corn, wheat, and hog type of farming area,[6] and produces more swine than any other section of the State, largely because of the abundance of corn and pasture. Most of the swine are raised in the Wisconsin drift regions, where farms raising 100

[6] YOUNG, E. C., and ELLIOTT, F. F. TYPES OF FARMING IN INDIANA. Ind. Agr. Expt. Sta. Bul 342, 72 pp., illus 1930

head or more a year are not uncommon. The principal breeds are Duroc-Jersey, Poland China, Berkshire, and Chester White. In 1939, 9,557 hogs and pigs were bought, 63,679 sold, and 3,444 slaughtered on farms. Although the larger part of the feed for hogs—mainly corn and legume pasture—is grown on the farm, it is supplemented on most farms by commercial feeds. Practically all the swine are marketed in Indianapolis, except a small number sold locally and as breeding stock.

Sheep are distributed throughout the county and, in general, the flocks are not large. Most of the sheep sold are raised on the farms, but a few farmers buy feeder sheep or lambs, generally from the southwestern or western parts of the country, and fatten them on the farm for marketing in Indianapolis or other nearby markets.

In the important poultry producing industry, 259,315 chickens were raised and 99,604 sold in 1939, and 573,674 dozen eggs were produced. Poultry other than chickens consists of a few turkeys, geese, ducks, and guineas on many farms. Almost every farm has from a few dozen to more than 100 laying hens of a wide variety of both mixed and pure breeds, and several that specialize in poultry have several hundred, principally Leghorn and other high-producing breeds. In 1939, on 36 farms the major source of income was derived from poultry and poultry products, the larger part of which was marketed locally; but some farmers, especially those specializing in this industry, ship to outside markets, where they generally obtain a premium price.

Increased use of mechanized farm equipment has been responsible for a steady decline in the number of horses and mules on farms in the last 20 years. Part of the work animals are raised on the farm and part purchased from adjacent areas. Practically all the feed for both horses and mules, chiefly oats and hay, is grown on the farm.

## TYPES OF FARMS

The 1940 Federal census classified the farms by major source of income in 1939. Accordingly, in Johnson County 718 farms were classified as deriving their major source of income from livestock, 448 from field crops, 263 from dairy products, 165 from vegetables harvested for sale, 36 from poultry and poultry products, 15 from fruits and nuts, 7 from horticultural specialties, and 3 from forest products, and 271 were classified as subsistence farms.

## LAND USE

The most extensive agricultural development was reached about 1910, when 95.8 percent of the county was in farm land, of which 84.8 percent was improved. The 1940 census shows a decrease in the percentage of total farm land and improved farm land to 95.0 and 80.2 percent, respectively. Selected data on farms and farm lands, from the United States census for the years 1880 to 1940, inclusive, are given in table 5.

Although the total land in farms increased from 186,653 acres in 1930 to 191,611 acres in 1940, there was a slight decrease in cropland harvested (109,163 acres) in 1939 from that harvested (121,530 acres) in 1929. Crop-failure land decreased from 2,649 acres in 1929 to 1,782 in 1939, but idle or fallow cropland increased from 3,573 acres in 1929 to 8,574 in 1939. Plowable pasture increased about 55 percent from 1929 to 1939, from 21,887 to 34,087 acres. Woodland occupied only 16,412 acres in 1939, or about 81 percent of the woodland area in 1929. The larger areas of woodland occur on the steeper slopes in the southwestern part, but the

greater part of the woodland is in small stands on a great number of farms. Of the total acreage in farms 153,606 acres, or about 80 percent, was available for crops in 1939, of which about 58 percent (110,945 acres) was used for that purpose. The rest of the farm land in 1939, including pasture other than woodland and plowable, all wasteland, house yards, barnyards, feed lots, lanes, and roads, occupied 21,593 acres.

TABLE 5.—*Number of farms, land in farms, and farm operation in Johnson County, Ind., in census years*

| Year | Farms | | Land in farms | | | | Farms operated by— | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number | Average Size | Total | Proportion of county | Improved land per farm | | Owners | Tenants | Managers |
| | | *Acres* | *Acres* | *Percent* | *Acres* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1880 | 2,113 | 92.7 | 195,851 | 95.0 | 68.1 | 73.5 | 70.1 | 29.9 | ---------- |
| 1890 | 1,920 | 97.6 | 187,314 | 90.9 | 78.2 | 80.1 | 67.9 | 32.1 | ---------- |
| 1900 | 2,053 | 94.8 | 194,624 | 94.4 | 77.6 | 81.9 | 66.3 | 33.0 | 0.7 |
| 1910 | 2,025 | 97.5 | 197,403 | 95.8 | 82.7 | 84.8 | 64.2 | 35.4 | .4 |
| 1920 | 2,051 | 96.0 | 196,932 | 95.6 | 80.2 | 83.6 | 61.4 | 37.7 | .9 |
| 1930 | 1,876 | 99.5 | 186,653 | 90.6 | 79.8 | 80.2 | 59.7 | 39.8 | .5 |
| 1940 | 1,945 | 98.5 | 191,611 | 95.0 | 79.0 | 80.2 | 60.2 | 38.5 | 1.3 |

The farms range in size from 3 to 999 acres, about 35 percent containing 100 to 259 acres, and nearly 44 percent, representing a total of 96,485 acres or 50 percent of the farm land in 1940, from 70 to 179 acres. Farms containing less than 70 acres represented 42 percent of the 1,945 farms in 1940; 70 to 139 acres, 34 percent; 140 to 219 acres, 16 percent; and 220 to 999 acres, 8 percent.

## FARM TENURE

The 1940 United States census reported 60.2 percent of the farms in the county operated by owners, 38.5 percent by tenants, and 1.3 percent by managers. The percentage of farms operated by owners declined steadily from 70.1 percent in 1880 to 59.7 percent in 1930, with a slight increase to 60.2 percent in 1940. During the same period the rate of tenancy increased from 29.9 percent in 1880 to 39.8 percent in 1930, then decreased to 38.5 percent in 1940. Less than one-fifth of the tenant-operated farms were operated on a cash-rent basis in both 1930 and 1940, and about 69 percent on share-tenant and cropper basis in 1940. On the share basis the tenant receives one-third to one-half of the total crop produced, with some provision made for living privileges. Where livestock is produced the same variations exist. When the land is rented for cash, the price an acre varies with the productivity of the soil, farm improvements and facilities, and current economic conditions.

## FARM INVESTMENTS AND EXPENDITURES

The average value of land and buildings in 1940 was $9,037 per farm and $91.73 per acre, a slight decrease from that in 1930 of $10,061 per farm and $101.12 per acre. The average value of all property per farm in 1940 was $10,619, of which 85.1 percent represented land and buildings; 6.8 percent, implements; and 8.1 percent, domestic animals, poultry, and bees.

In 1940, 967 tractors were reported on 911 farms, and 476 trucks on 445. Much of the farming operations, especially plowing and preparation of seedbeds, is accomplished with power machinery. A large part of the corn is harvested with mechanical pickers, and small grain and soybeans generally are harvested with combines.

An expenditure of $268,933 for feed in 1939 was reported by 1,289 farms, an average of $208.64 each and a decrease from the 1929 average of $312.75. The purchase of 4,110 tons of commercial fertilizer in 1939 was reported by 1,289 farms at a total cost of $117,864, or an average of $91.44 a farm. In addition 987 tons of liming materials, largely in the form of ground agricultural limestone, was purchased by 59 farms. This represented an expenditure of $2,417, or an average of $40.97 a farm.

A total of $258,940 was paid for labor (exclusive of housework and contract constructional work) on 808 farms in 1939, an average of $320.47 each. About 52 percent of this expenditure was for labor hired by the day or week, 18 percent by the month, and 30 percent for other labor, including piece work and contract farm labor. Extra farm labor is extensively used in certain periods, especially during the vegetable-harvesting season. During this period labor requirements are so great that workers are imported from neighboring States, especially Kentucky. Local labor generally is adequate during the rest of the year. On the larger farms labor is hired on a weekly, monthly, or yearly basis, and housing facilities and various food and other incidental subsistence items often are included in the contract.

## SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their characteristics, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and road or railroad cuts and other exposures studied. Each excavation exposes a series of layers or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The chemical reaction of the soil and its content of lime and salts are determined by simple tests.[7]

More complete mechanical and chemical determinations are made in the laboratory. This includes the determinations of the percentages of the various constituents, as fine gravel, fine, medium and coarse sand, silt, and clay of a soil type, and the determination of the percentages of nitrogen, phosphate, potash and various other chemical constituents. The drainage, both internal and external, and other external features, as the relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

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[7] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. Indicator solutions are used to determine the chemical reaction. The presence of lime is detected by the use of a dilute solution of hydrochloric acid. Terms used to describe the reaction and commonly used in this report are as follows:

| | *pH Value* | | *pH Value* |
|---|---|---|---|
| Extremely acid | Below 4.5 | Neutral | 6.6–7.3 |
| Very strongly acid | 4.5–5.0 | Mildly alkaline | 7.4–8.0 |
| Strongly acid | 5.1–5.5 | Strongly alkaline | 8.1–9.0 |
| Medium acid | 5.6–6.0 | Very strongly alkaline | 9.1 and higher |
| Slightly acid | 6.1–6.5 | | |

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land to the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Miami, Russell, Fox, Brookston, Crosby, and Fincastle are names of important soil series in Johnson County.

Within a series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture—fine sandy loam, loam, silt loam, or silty clay loam—is added to the series designation to give complete name to the soil type. Except for the texture of the surface soil and upper subsoil, these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related. Miami silt loam and Miami loam are soil types within the Miami series.

A soil phase is a variation within the type, differing from it in some minor feature, generally external, that may be of special practical significance. For example, within the normal range of relief of a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Differences in relief, stoniness, and degree of accelerated erosion may be shown as phases. Even though no important differences may be apparent in the soil itself or in its capability for the growth of the native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instance the more sloping parts of the soil type may be segregated on the map as a sloping or a steep phase. An example in the Miami series is Miami silt loam, sloping phase.

Aerial photographs (pl. 1) are used as a base for mapping soils in Indiana. The pictures are taken from an airplane flying at a height of about 13,500 feet, and each picture (scale 3.17 inches to a mile) covers about 4½ square miles. The photographs are covered with sheets of cellulose acetate, a thin transparent material, and soil boundaries, streams, roads, houses, and other features are drawn on this in the field. After the entire county is mapped the sheets are reduced to a scale of 2 inches to 1 mile and assembled on a base map prepared on the same scale. The assembled map is printed in colors, with each soil separation having a distinguishing color, letter, and ruling designation. For example, all areas of Miami silt loam are designated on the map, which accompanies this report, with the symbol Mt, and are printed in a green color.

## SOILS

The soils of Johnson County represent a very wide variation in color, natural drainage conditions, fertility, consistence, slope, and susceptibility to erosion. These characteristics are very significant in determin-

ing soil productivity, and one or more of them are often the limiting factors in the agricultural use made of the various types and phases.

Soil types, embodying different combinations of the above-mentioned characteristics, are often closely associated, and a field unit often includes a wide range of soil conditions. This fact makes it very difficult to apply individual systems of crop rotation, fertilization, and other soil improvements to the individual soils. Thus more general methods of management are used.

In surface texture the soils range from fine sandy loam to silty clay loam and in color from light gray in the poorly drained soils of uplands and terraces to very dark brownish gray or nearly black in the depressional soils of the uplands and terraces and in the organic soils.

The color of the subsoil ranges from gray or mottled gray, yellow, and rust brown to dark gray, and the texture varies from friable fine sandy loam in the wind-deposited soils to heavy plastic silty clay loam in the dark depressional soils.

Natural drainage conditions range from very poor to excessive. Water erosion is potentially severe on soils having sloping to steep topography, and where clean-cultivated crops are extensively grown without much thought to erosion control, accelerated erosion is severe.

About 27 percent of the soils are dark-colored, the surface soil being relatively high in organic-matter content, and the rest are light-colored and relatively low in organic-matter content.

The soils developed on the Illinoian glacial drift and Borden sandstone, siltstone, and shale, and associated alluvial soils are all strongly acid. Those developed on Early Wisconsin and Late Wisconsin drift and on glaciofluvial outwash plains and terraces are, in general, medium acid to neutral.

The imperfectly drained soils in the Illinoian drift region and the poorly drained light-colored soils of the Wisconsin glacial drift region have rather compact siltpans in the subsoil.

The distribution and association of the more extensive soils as well as their relative importance within geographic units are shown in figure 3.

## SOIL SERIES AND THEIR RELATIONS

A key to the soil series of Johnson County is presented in table 6. The great soil groups named at the heads of columns follow the classification of soils as given in the Yearbook of Agriculture, 1938.[8] The Roman numerals in the column subheads are based on the Indiana system of soil profile designation.[9] Soil series listed in a horizontal line in the columns are developed on similar parent material, differences in profile development being largely dependent on natural drainage conditions during development. Such a grouping of series is called a soil catena. Series listed under a given Roman numeral have similar natural drainage conditions; differences in characteristics in each drainage profile within the county are due to the kinds of parent material on which the soils are developed and to differences in age.

Conforming with the groupings in the first column, four main divisions are made of the soils of the county: (1) Soils of the uplands, (2) soils of

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[8] BALDWIN, M., KELLOGG, C. E., and THORP, J. SOIL CLASSIFICATION. U. S. Dept. Agr. Yearbook 1938 (Soils and Men): 979–1001. 1938.

[9] BUSHNELL, T. M. THE STORY OF INDIANA SOILS. Dept. of Agron., Purdue Univ. Agr. Expt. Sta., Spec. Cir. No. 1, 52 pp., illus. 1944.

TABLE 6.—*Key to the soils of*

| Topographic position and derivation | Lithosols (shallow soils) | Gray-Brown Podzolic soils | |
|---|---|---|---|
| Major profile (based on Indiana system of soil profile designation [2]) | VI | V | IV |
| Drainage | Rapid surface run-off | Good to excessive internal. | Good internal; good to excessive run-off |
| Relief | Principally steep slopes | Nearly level to rolling | Undulating to steeply sloping. |
| Color of— Surface soil [3] | Light grayish brown to grayish yellow. | Light grayish brown | Light grayish brown to yellowish brown. |
| Subsurface soil | Light brownish yellow to light yellowish brown. | Light yellowish brown to yellowish brown. | do |
| Upper subsoil | Brownish yellow | Yellowish brown to weak reddish brown. | Yellowish brown to brownish yellow. |
| Lower subsoil | do | do | do |
| SOILS OF UPLANDS AND GLACIOFLUVIAL | | | |
| Soils of the uplands, the parent material derived from— | | | |
| Calcareous Late Wisconsin glacial drift | | Bellefontaine | Miami |
| Calcareous Early Wisconsin glacial drift | | Bellefontaine | Russell |
| Calcareous Illinoian glacial drift | | | Cincinnati |
| Medium-grained sandstone, siltstone, and shale of Borden formation | Muskingum | | Zanesville; Wellston |
| Calcareous wind-deposited sand and silt of Wisconsin glacial age | | Princeton | |
| Soils of glaciofluvial outwash plains and terraces, the parent material derived from— | | | |
| Calcareous stratified gravel and sand of Wisconsin age | | Fox; Nineveh [4] | |
| Calcareous stratified silt, sand, gravel, and clay. | | Martinsville | |
| ALLUVIAL | | | |
| Soils of overflow bottoms, the parent material derived from— | | | |
| Neutral to slightly alkaline alluvium from Wisconsin glacial drift regions | | | Genesee; Ross [4] |
| Strongly acid alluvium from Illinoian glacial drift and Borden standstone, siltstone, and shale regions | | | Pope |
| ORGANIC SOILS IN | | | |
| Soils of depressions in the uplands, the parent material derived from muck and peat underlain by silty sand or clay. | | | |

[1] Soils that would key into many of the blank spaces have been mapped elsewhere in the State

[2] BUSHNELL, T M THE STORY OF INDIANA SOILS. Dept. of Agron , Purdue Univ. Agr. Expt Sta , Spec Cir No. 1, 52 pp , illus 1944

[3] Refer to color in cultivated areas.

*Johnson County, Ind.* [1]

| Planosols and Semi-Planosols | | | Wiesenboden (glei) soils | | Bog soils |
|---|---|---|---|---|---|
| III | II | I | VIII | IX | X |
| Good to fair internal; good to slow surface runoff. | Imperfect internal, slow surface runoff. | Poor internal, very slow surface runoff. | Very poor internal, ponding | Very poor internal; ponding | Very poor internal, ponding. |
| Gently undulating to gently rolling. | Nearly level to undulating | Nearly level | Level to shallow depressions. | Deeper depressions. | Shallow to deep depressions |
| Light yellowish brown to brownish gray. | Brownish gray to light brownish gray. | Light gray | Dark gray to very dark brownish gray | Very dark gray to black | Very dark gray to black. |
| Light yellowish brown to light brownish yellow. | Light brownish gray to brownish gray. | Light gray to gray. | Dark gray to dark brownish gray. | Very dark gray. | Do. |
| Light brownish yellow. | Mottled gray, yellow, and rust brown. | Mottled gray, yellow, and rust brown. | Mottled gray, yellow, and rust brown. | Gray | Do. |
| Mottled gray, yellow, and rust brown. | do | do | do | Mottled gray, yellow, and rust brown. | Very dark gray to light brownish yellow. |

OUTWASH PLAINS AND TERRACES

| | | | | | |
|---|---|---|---|---|---|
| | Crosby | Bethel | Brookston | Clyde | |
| | Fincastle | Delmar | Brookston | Clyde | |
| Gibson | Avonburg | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | Homer | | Westland | Abington | |
| | Whitaker | | Mahalasville | | |

SOILS [5]

| | | | | | |
|---|---|---|---|---|---|
| Eel | | | | | |
| | | | | | |
| Philo | | | | | |

UPLAND DEPRESSIONS

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Carlisle. |

[4] Ross and Nineveh soils have dark-brown surface soils and upper subsoils.
[5] The alluvial soils resemble those in the columns above them in color and drainage characteristics They do not have well-defined horizons.

the glaciofluvial outwash plains and terraces, (3) soils of the overflow bottoms, and (4) organic soils in upland depressions.

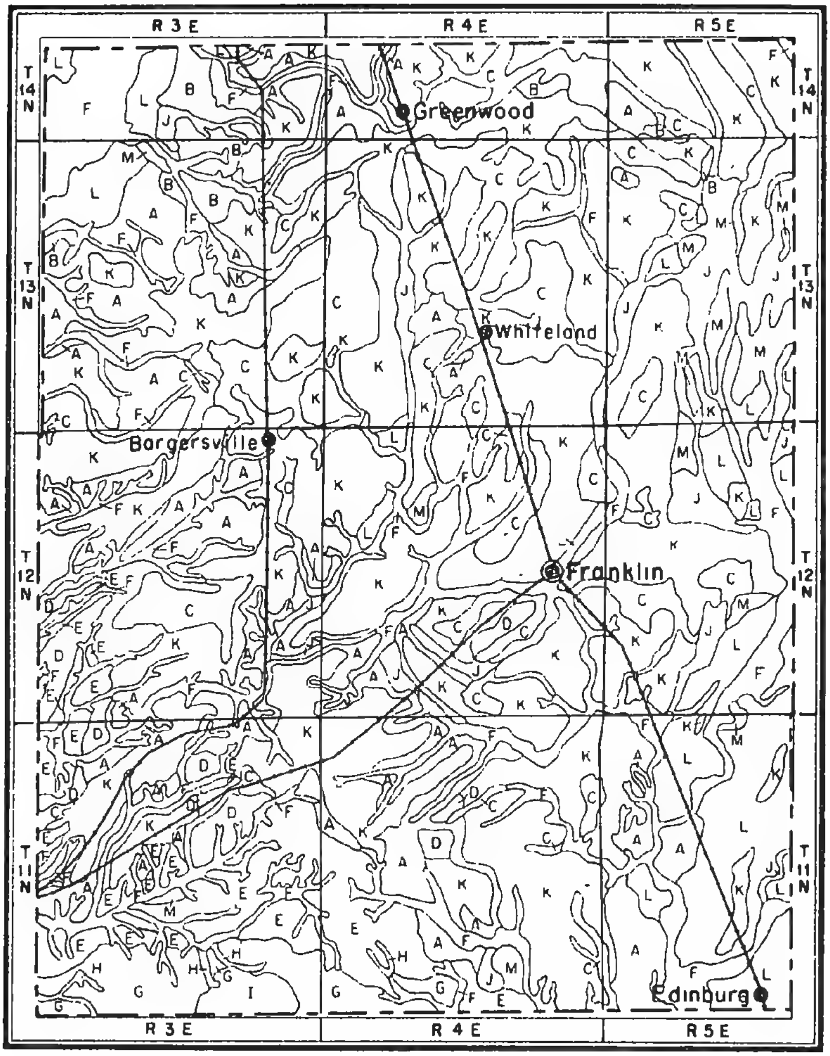


Figure 3.—Soil association map of Johnson County, Ind.: *A*, Miami silt loam and its sloping and eroded phases, Miami loam, Crosby silt loam; *B*, Bellefontaine loam and its level phase; *C*, Brookston silty clay loam, Crosby silt loam, Clyde silty clay loam, Bethel silt loam; *D*, Fincastle silt loam, Brookston silty clay loam, Russell silt loam; *E*, Russell and Fincastle silt loams, Brookston silty clay loam; *F*, Genesee silt loam, Genesee loam, Genesee fine sandy loam, Eel silt loam, Eel and Ross silty clay loams; *G*, Cincinnati silt loam and its steep and eroded phases, Gibson silt loam; *H*, Pope and Philo silt loams; *I*, Muskingum stony silt loam, Zanesville silt loam; *J*, Westland Mahalasville, and Abington silty clay loams, Homer silt loam, Whitaker loam; *K*, Crosby silt loam, Brookston silty clay loam, Miami silt loam; *L*, Fox loam, Fox and Homer silt loams, Westland silty clay loam; *M*, Whitaker silt loam, Whitaker loam, Mahalasville silty clay loam.

## SOILS OF THE UPLANDS

The soils of the uplands are grouped on the basis of the parent material into soils developed on (1) calcareous Late Wisconsin glacial drift; (2) calcareous Early Wisconsin glacial drift; (3) calcareous Illinoian glacial drift; (4) medium-grained sandstone, siltstone, and shale of the Borden formation; and (5) calcareous wind-deposited sands of Wisconsin glacial age.

### SOILS DEVELOPED ON CALCAREOUS LATE WISCONSIN GLACIAL DRIFT

The soils developed on calcareous Late Wisconsin glacial drift—the Bellefontaine, Miami, Crosby, Bethel, Brookston, and Clyde series—occupy about 85 percent of the upland areas except in the southwestern part, or about 65 percent of the total area. All are developed on calcareous till composed of unassorted silt, clay, sand, and rock fragments with the exception of Bellefontaine soils, which are developed on loose calcareous gravel and sand. Free lime carbonates have been leached to an average depth of about 36 inches.

Bellefontaine soils are well to excessively drained and occur on smooth to rolling relief, often on kames and eskers. The surface soil is light yellowish brown; the subsoil yellowish brown to weak reddish brown; and gray and yellow loose calcareous gravel and sand occur at a depth of 36 to 45 inches.

Miami soils are well drained and occur on undulating to steeply sloping relief. Erosion is potentially severe. The surface soil is light yellowish brown and the subsoil yellowish brown to brownish yellow; the underlying material of gray and yellow calcareous glacial till occurs at an average depth of about 36 inches.

The light-colored imperfectly drained Crosby soil occurs on nearly level to undulating relief, thus erosion is not a serious problem. The surface soil is brownish gray and the subsoil mottled gray, yellow, and rust brown; the underlying gray and yellow calcareous till occurs at a depth of about 36 inches.

The poorly drained light-colored Bethel soil occurs on nearly level relief where erosion is not a problem. The surface soil is light gray and the subsoil mottled gray, yellow, and rust brown; the underlying gray and yellow calcareous glacial till lies at a depth of about 36 inches.

The dark-colored very poorly drained Brookston soil occupies slight depressions and rather broad flats. The surface soil is dark gray to very dark brownish gray and the subsoil mottled gray, yellow, and rust brown; the underlying calcareous glacial till occurs at a depth of 40 to 60 inches.

The Clyde soil is very dark-colored and very poorly drained, and occupies the deeper depressions. The surface soil and the upper subsoil, to a depth of 16 to 18 inches, are very dark gray to nearly black; the subsoil is gray, becoming mottled gray, yellow, and rust brown below a depth of 24 to 30 inches; and the calcareous glacial till lies at a depth of 40 to 60 inches.

### SOILS DEVELOPED ON CALCAREOUS EARLY WISCONSIN GLACIAL DRIFT

The soils developed on calcareous Early Wisconsin glacial drift—the Bellefontaine, Russell, Fincastle, Delmar, Brookston, and Clyde series—occupy the uplands in the southwestern part of the county between areas of Late Wisconsin and Illinoian glacial drift. They are inextensive, covering only about 10 percent of the county area, and are about as pro-

ductive as the corresponding soils developed on Late Wisconsin glacial drift, except that free lime carbonates have been leached to a depth of about 45 inches and that the lighter colored soils are more acid than the light-colored soils of that group.

The Bellefontaine soils associated with the Russell and other soils of this group have a somewhat more grit-free surface soil and upper subsoil, higher acidity, and greater depth to loose calcareous gravel and sand than those associated with the Late Wisconsin glacial drift group.

The Russell soils are well drained and occur on undulating to sloping relief, where erosion is potentially severe. They differ from the Miami soils in the grit-free texture of the surface soil and upper subsoil, in the higher acidity of the surface soil and subsoil, and in being leached of free lime carbonates to a depth of 45 inches or more.

The imperfectly drained light-colored Fincastle soil is developed on nearly level to gently undulating relief. It is similar to the Crosby in natural drainage and relief, but differs in the grit-free textures of the surface soil and upper subsoil, the stronger acidity of the surface soil and subsoil, and the greater depth to calcareous till.

The poorly drained light-colored Delmar soil, occurring on nearly level relief, is similar to the Bethel in natural drainage and relief, but differs in having a grit-free surface soil and upper subsoil, stronger acidity of the surface soil and subsoil, and greater depth to calcareous till.

The Brookston and Clyde soils associated with this group have in general slightly lower organic content and greater depth to calcareous glacial till than those associated with soils of the Late Wisconsin glacial drift.

### SOILS DEVELOPED ON CALCAREOUS ILLINOIAN GLACIAL DRIFT

The soils developed on calcareous Illinoian glacial drift—the Cincinnati, Gibson, and Avonburg series—occupy upland areas in the extreme southwestern part and are very inextensive, covering only about 2 percent of the total area. These soils in general are low in natural productivity, strongly to very strongly acid, and leached of free lime carbonates to an average depth of about 120 inches.

The Cincinnati soils are well drained and occur on undulating to steep relief. Erosion is potentially severe, and the steep sloping areas are not suited to agriculture. The surface soil is light yellowish brown and the subsoil yellowish brown to brownish yellow, with a thin siltpan development at a depth of 30 to 36 inches, underlain by calcareous glacial till at a depth of about 120 inches.

The moderately well-drained Gibson soil occupies gently undulating to gently sloping relief, and erosion is not a serious problem. The grit-free surface soil is light yellowish brown to brownish gray, the upper subsoil light brownish yellow, and the lower subsoil mottled gray, yellow, and rust brown, with a siltpan development at a depth of 30 to 40 inches, underlain by calcareous glacial till at a depth of about 120 inches.

The light-colored imperfectly drained Avonburg soil is developed on nearly level to gently undulating relief. In natural drainage and relief it is similar to the Crosby and Fincastle soils but differs from them in the greater depth of the grit-free subsoil, the presence of a heavy siltpan horizon at a depth of 30 to 36 inches, the strongly to very strongly acid reaction of the surface soil and subsoil, and the occurrence of calcareous glacial till at a depth of about 120 inches.

Vertical aerial photograph of a part of Johnson County, showing the city of Franklin in
dark-colored areas are Brookston silty clay loam, and the light-colored ones are largely
of Miami silt loam. The small open ditch drainageway on the left edge is fed by tile dra
soils.

*A*, Cutting wheat on Brookston silty clay loam and Crosby silt loam. This field averaged 27 bushels an acre in 1945. *B*, Young corn on Brookston silty clay loam and Crosby silt loam, with small areas of Miami silt loam in background.

638564—48 (Face P. 25)

#### SOILS DEVELOPED ON MEDIUM-GRAINED SANDSTONE, SILTSTONE, AND SHALE OF THE BORDEN FORMATION

The soils developed on medium-grained sandstone, siltstone, and shale of the Borden formation—the Muskingum, Zanesville, and Wellston series—occupy only a few small areas in the extreme south-central to southwestern part, west of Peoga, totaling less than 1 percent of the area. The reaction is strongly to very strongly acid, and erosion is potentially severe. Natural productivity is low to very low, and the strongly sloping and steep areas are not suited to agriculture but are better adapted to forest.

The Muskingum soil occupies steep slopes, and drainage is excessive. It is essentially nonagricultural and better suited to forest. Numerous rock fragments are on the surface and thoughout the light brownish-yellow surface soil and subsoil, and bedrock lies at a depth of 12 to 25 inches.

The well-drained Zanesville soils, occurring on undulating to sloping relief, have a light yellowish-brown grit-free surface soil and yellowish-brown to brownish-yellow subsoil, with a siltpan development at a depth of 30 to 36 inches, underlain by bedrock at a depth of about 60 inches.

The Wellston soil is well drained and developed on undulating to sloping relief, usually on the narrow ridge crests. It has a light yellowish-brown suface soil and yellowish-brown to brownish-yellow subsoil, underlain by bedrock at a depth of about 30 inches.

#### SOIL DEVELOPED ON CALCAREOUS WIND-DEPOSITED SAND AND SILT OF WISCONSIN GLACIAL AGE

Princeton fine sandy loam is the only soil developed on calcareous wind-deposited sand and silt of Wisconsin glacial age. It occurs on nearly level to rolling relief, often dunelike, principally along the bluffs of the valley of the White River. The light yellowish-brown surface soil and yellowish-brown to brownish-yellow subsoil are underlain by gray and yellow loose calcareous sand at a depth of 50 to 60 inches.

### SOILS OF THE GLACIOFLUVIAL OUTWASH PLAINS AND TERRACES

The soils of the glaciofluvial outwash plains and terraces are divided into two groups—soils developed on (1) calcareous stratified gravel and sand of Wisconsin age, and (2) calcareous stratified silt, sand, gravel, and clay.

#### SOILS DEVELOPED ON CALCAREOUS STRATIFIED GRAVEL AND SAND OF WISCONSIN AGE

Soils developed on calcareous stratified gravel and sand of Wisconsin age—the Fox, Nineveh, Homer, Westland, and Abington series—comprise 7.6 percent of the area, occupying the terraces and outwash plains, principally the terraces in the valleys of the rivers and larger streams and the outwash plains in the eastern part.

The Fox soils are well to excessively drained, occurring principally on nearly level to gently undulating relief, with only a small area on sloping relief. Except on the sloping areas, erosion is not a serious problem. The light yellowish-brown surface soil and yellowish-brown to weak reddish-brown waxy and gravelly subsoil are underlain at a depth of 36 to 45 inches by calcareous stratified gravel and sand.

The Nineveh soil occurs on nearly level relief and is similar to the Fox soils, except that the surface soil and subsoil are darker colored, higher in organic matter, and only slightly acid to neutral.

The imperfectly drained light-colored Homer soil occurs on nearly level relief. The surface soil is brownish gray, and the waxy and gravelly subsoil is mottled gray, yellow, and rust brown, underlain at a depth of 36 to 45 inches by calcareous stratified gravel and sand.

The dark-colored Westland soil is very poorly drained and occurs in slight depressions, old glacial drainageways, and broad flats of the terraces and outwash plains. In natural drainage and relief it is similar to the Brookston and Mahalasville soils but differs in having a waxy and gravelly clay loam subsoil, containing considerable quantity of rounded pebbles and gravel, and in being underlain at a depth of 45 to 60 inches by loose calcareous stratified gravel and sand.

The Abington is a very poorly drained dark-colored soil of the deeper depressional areas. It is similar to the Clyde soil in natural drainage and relief but has a gravelly and waxy clay loam lower subsoil and is underlain at a depth of 45 to 65 inches by loose calcareous stratified gravel and sand.

### SOILS DEVELOPED ON CALCAREOUS STRATIFIED SILT, SAND, GRAVEL, AND CLAY

The soils of the glaciofluvial outwash plains and terraces developed on calcareous stratified silt, sand, gravel, and clay—the Martinsville, Whitaker, and Mahalasville—occupy only 4.2 percent of the area, occurring principally on the outwash plains in the eastern part and on terraces in the valleys of the larger streams and rivers. They are associated with and resemble the soils of the first group, but the subsoil contains less gravel and rounded pebbles and the underlying material is predominantly silt and sand instead of loose gravel and sand.

The Martinsville soils are well drained and occur on nearly level to undulating relief; thus erosion is not a problem. The surface soil is light yellowish brown; the subsoil, which contains less rounded pebbles and gravel than the subsoil of the Fox series, is yellowish brown to weak reddish brown; and the underlying predominantly calcareous stratified silt and sand lies at a depth of 36 to 45 inches.

The imperfectly drained light-colored Whitaker soils, developed on nearly level relief, are similar to the Homer soil in natural drainage and relief but differ in having less rounded gravel and pebbles in the surface soil and subsoil and calcareous silt and sand instead of loose calcareous gravel and sand at a depth of about 36 inches.

In relief and natural drainage the very poorly drained dark-colored Mahalasville soil of the shallow depressions and broad flats is similar to the Westland and Brookston soils, but differs from the Westland in having less rounded gravel and sand, and from the Brookston in having a slightly waxy subsoil containing some rounded gravel and pebbles instead of angular rock fragments and in being underlain by stratified silt and sand instead of unassorted glacial till.

### SOILS OF OVERFLOW BOTTOMS

The soils of the overflow bottoms are divided into two groups—(1) soils on neutral to slightly alkaline alluvium from Wisconsin glacial drift regions, and (2) soils on strongly acid alluvium from Illinoian glacial drift and Borden sandstone, siltstone, and shale regions.

#### SOILS ON NEUTRAL TO SLIGHTLY ALKALINE ALLUVIUM FROM WISCONSIN GLACIAL DRIFT REGIONS

The soils of the overflow bottoms on neutral to slightly alkaline alluvium from Wisconsin glacial drift regions—the Genesee, Ross, and Eel series—are subject to overflow during periods of extremely high water, a large part being flooded an average of at least once a year. They occupy 10.3 percent of the county, the larger areas occurring in the flood plains of the White and Blue Rivers and Sugar Creek, with smaller areas adjacent to the small drainageways throughout the regions of Wisconsin glacial drift. These soils are very productive, but there is always danger to crops from floodwaters.

The Genesee soils are well drained and occur on nearly level relief. The surface soil is light yellowish brown to yellowish brown and the subsoil yellowish brown to brownish yellow. Below a depth of 36 inches the material is extremely variable in texture and composition.

The well-drained Ross soil differs from the Genesee soils in the darker color and higher organic content of the surface and subsurface horizons.

The moderately well-drained to imperfectly drained Eel soils occur on nearly level relief or in slight depressions in temporary drainageways made by floodwaters. The surface soil is light yellowish brown to brownish gray, the upper subsoil light brownish yellow, and the lower subsoil mottled gray, yellow, and rust brown below a depth of 16 to 24 inches.

#### SOILS ON STRONGLY ACID ALLUVIUM FROM ILLINOIAN GLACIAL DRIFT AND BORDEN SANDSTONE, SILTSTONE, AND SHALE REGIONS

The soils of the overflow bottoms on strongly acid alluvium from Illinoian glacial drift and Borden sandstone, siltstone, and shale regions—the Pope and Philo series—occur adjacent to the small streams. They are very inextensive, occupying only about 0.3 percent of the area. Although medium in productivity they are less productive than the soils of the sweet alluvial areas.

The well-drained Pope soil, occurring on nearly level relief, has a light yellowish-brown surface soil and yellowish-brown to brownish-yellow subsoil. Below a depth of 30 inches the texture of the subsoil is variable.

The moderately well-drained Philo soil, occurring on nearly level relief, has a light yellowish-brown surface soil and a light brownish-yellow subsoil to a depth of 16 to 24 inches below which it becomes mottled gray, yellow, and rust brown.

#### ORGANIC SOILS IN UPLAND DEPRESSIONS

Carlisle silty muck, the only organic soil in the county, occupies deep depressional areas in the Wisconsin glacial regions and is very inextensive, covering only 0.1 percent of the county. It consists of an accumulation of plant remains, chiefly moss, sedge, reed, and marsh grass, and some wood, with a considerable quantity of silty mineral material in the surface and subsurface horizons.

## DESCRIPTIONS OF SOIL UNITS

In the following pages the individual soil types are described in alphabetic order and their relation to agriculture is discussed. Their location and distribution are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 7.

TABLE 7.—*Acreage and proportionate extent of the soils mapped in Johnson County, Ind.*

| Soil type | Acres | Percent | Soil type | Acres | Percent |
|---|---|---|---|---|---|
| Abington silty clay loam | 1,408 | 0.7 | Mahalasville silty clay loam | 3,712 | 1.8 |
| Avonburg silt loam | 64 | (1) | Martinsville loam | 2,496 | 1.2 |
| Bellefontaine loam | 2,560 | 1.3 | Martinsville silt loam | 1,408 | .7 |
| Level phase | 704 | .3 | Miami loam | 1,472 | .7 |
| Bethel silt loam | 192 | .1 | Miami silt loam | 29,696 | 14.4 |
| Brookston silty clay loam | 43,520 | 21.1 | Eroded phase | 4,992 | 2.4 |
| Carlisle silty muck | 192 | .1 | Gullied phase | 448 | .2 |
| Cincinnati silt loam | 896 | .4 | Sloping phase | 4,224 | 2.1 |
| Eroded phase | 1,024 | .5 | Muskingum stony silt loam | 896 | .4 |
| Shallow phase | 128 | .1 | Nineveh loam | 1,216 | .6 |
| Steep phase | 1,664 | .8 | Philo silt loam | 128 | .1 |
| Clyde silty clay loam | 256 | .1 | Pope silt loam | 448 | .2 |
| Crosby silt loam | 53,760 | 26.1 | Princeton fine sandy loam | 192 | .1 |
| Delmar silt loam | 64 | (1) | Ross silty clay loam | 768 | .4 |
| Eel loam | 384 | .2 | Russell silt loam | 5,376 | 2.6 |
| Eel silt loam | 7,296 | 3.6 | Eroded phase | 1,728 | .8 |
| Eel silty clay loam | 2,176 | 1.1 | Sloping phase | 2,944 | 1.4 |
| Fincastle silt loam | 2,624 | 1.3 | Wellston silt loam | 128 | .1 |
| Fox loam | 6,208 | 3.0 | Westland silty clay loam | 4,032 | 2.0 |
| Sloping phase | 512 | .2 | Whitaker loam | 384 | .2 |
| Fox silt loam | 1,344 | .7 | Whitaker silt loam | 640 | .3 |
| Genesee fine sandy loam | 192 | .1 | Zanesville silt loam | 64 | (1) |
| Genesee loam | 2,688 | 1.3 | Eroded phase | 64 | (1) |
| Genesee silt loam | 7,424 | 3.6 | | | |
| Gibson silt loam | 512 | .2 | Total | 206,080 | 100.0 |
| Homer silt loam | 832 | .4 | | | |

1 Less than 0.1 percent.

**Abington silty clay loam.**—Developed on glaciofluvial outwash plains and terraces, this dark-colored soil is underlain by calcareous stratified gravel and sand and is the very poorly drained member of the catena that includes the Fox, Nineveh, Homer, and Westland soils.

This type covers a total of 1,408 acres on the deeper depressions, associated with the Westland, Mahalasville, and other soils of the outwash plains and terraces. The larger areas are along the east county line southeast of Rocklane and in the vicinity of Amity, with small areas occurring throughout the regions of outwash plains and terraces. Natural drainage is very poor, and though the greater part of the soil has been artificially drained sufficiently to permit cropping, small areas are still in need of more adequate drainage. The native vegetation consisted of marsh grasses and water-loving trees, including swamp white oak, ash, and elm.

Following is a profile description in cultivated areas:

0 to 7 inches, very dark gray to nearly black coarse granular silty clay loam, relatively high in organic content. In undisturbed areas there may be a 2- to 3-inch surface layer of black friable muck. Reaction, neutral to slightly acid.

7 to 18 inches, very dark gray gritty silty clay loam to gritty silty clay, containing numerous rounded pebbles The material breaks into irregular-sized angular pieces, plastic when moist and hard when dry. This layer is permeable to moisture movement and plant roots. Reaction, neutral.

18 to 30 inches, gray or light-gray silty clay loam to silty clay, with faint-yellow and rust-brown mottlings in lower part. Numerous small rounded pebbles and an occasional boulder are present. The material breaks into angular pieces, waxy and plastic when moist and hard when dry. Reaction, neutral.

30 to 54 inches, mottled gray, yellow, and rust-brown waxy silty clay loam to silty clay, breaking into large angular pieces, plastic when moist, sticky when wet, and hard when dry. The content of rounded pebbles and gravel increases with depth. Reaction, neutral.

54 inches +, gray and yellow loose calcareous stratified gravel and sand, usually showing horizontal bedding.

Variations in the profile characteristics are in the texture and thickness of layers and in depth to the underlying material. Areas of this soil

associated with the Martinsville and Mahalasville soils have a smaller quantity of rounded pebbles and gravel in the subsoil and are underlain by stratified silt and sand, with small quantities of clay and gravel.

This soil is cropped about the same as the associated Westland, Mahalasville, and other soils of the outwash plains and terraces. A common rotation includes corn, wheat or oats, and hay. Soybeans and special crops occupy small places in the rotation. Where a field unit is composed largely or wholly of this soil, corn is occasionally grown for 2 or more consecutive years.

Corn yields 40 to 60 bushels an acre under present management, with higher yields obtained when drainage is adequate and the proper fertilizer used. Wheat, oats, and other small grains are not so well adapted to this soil as to the better drained soils, because of the freezing out of fall-sown grains, and the lodging of grain due to high organic and nitrogen content of the soil. Wheat yields 15 to 18 bushels and oats 30 to 40. The common hay crops are a mixture of clover, alfalfa, timothy, and alsike, or clover or alfalfa grown alone. Clover and alfalfa may be successfully grown without liming the soil, but they are occasionally severely damaged by heaving or drowning out. Soybeans are well adapted, yielding 20 to 25 bushels an acre. Some special crops—tomatoes, sweet corn, and other vegetables—are grown, but to obtain good yields commercial fertilizer high in phosphate and potash should be applied.

**Avonburg silt loam.**—Imperfectly drained and light colored, this soil, developed on Illinoian glacial drift, is similar to Fincastle and Crosby silt loams in drainage conditions but differs in the strongly acid surface soil and subsoil, the heavy compact siltpan horizon in the subsoil, and greater depth to calcareous till.

This soil occupies only 64 acres on the broader flats in the southwestern part of the county in association with Gibson and Cincinnati silt loams. It forms a part of region G on the soil association map (fig. 3). The relief is nearly level to undulating, and external and internal drainage are imperfect. The native vegetation consisted chiefly of white and pin oaks, sweetgum, and black tupelo, with lesser quantities of beech, maple, and elm.

Following is a profile description in cultivated areas:

0 to 7 inches, light brownish-gray smooth friable granular silt loam, relatively low in organic matter. In undisturbed wooded areas the 2- or 3-inch surface layer is dark gray. Crayfish mounds are numerous on the surface, and many crayfish casts of gray silty material extend through this layer and into the layers below. Reaction, strongly acid.

7 to 10 inches, light brownish-gray to brownish-gray smooth friable coarse granular heavy silt loam to silty clay loam, with an occasional light-yellow mottling. This layer is permeable to moisture movement and plant roots. Reaction, strongly acid.

10 to 30 inches, mottled gray, yellow, and rust-brown smooth silty clay loam, breaking into ¼- to ½-inch subangular aggregates. This layer is permeable to moisture movement and plant roots. Reaction, strongly acid.

30 to 50 inches, mottled gray, yellow, and rust-brown compact silty clay loam, breaking into columns having a vertical length three or four times that of the horizontal and usually a 2- or 3-inch capping of light-gray silty material. This layer is impermeable to moisture movement and plant roots. Reaction, strong to very strongly acid.

50 to 120 inches, mottled gray, yellow, and rust-brown silty clay loam, more friable than the above layer and breaking into subangular pieces easily broken down into coarse granules when moist. A small quantity of grit, pebbles, and rock fragments in the upper part increases with depth. Reaction, strongly acid in the upper part and slightly acid in the lower.

120 inches +, gray and yellow compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics are in texture and thickness of layers and depth to calcareous till. The siltpan horizon is variable in thickness and depth, and in areas of shallower depths some difficulty is experienced in establishing tile drains.

The crop rotations are similar to those on Gibson and Cincinnati silt loams. The common rotation is corn, wheat, and hay.

Corn yields 20 to 25 bushels an acre on the wetter areas, and 30 to 40 where artificial drainage is adequate. Yields can be materially increased under good practices, which include adequate artificial drainage, plowing under all available plant residue, use of sufficient lime to correct acidity and assure a good stand of clover, and liberal use of commercial fertilizers. Wheat is the second most extensive crop grown, and the average yield of 12 bushels an acre can be increased under good management practices to 20 bushels or more. The soil is not commonly fertilized, but a few farmers apply 100 to 150 pounds an acre of commercial fertilizer.

This soil is not well adapted to growing oats, because its high moisture content delays seeding in spring, and drying is too rapid in summer.

Hay crops usually include a mixture of timothy, clover, and redtop, with some clover or timothy grown alone. Timothy is probably better adapted than clover to this soil. Unless the acidity is corrected by sufficient applications of lime (3 to 4 tons an acre), it is difficult to obtain good stands of clover.

**Bellefontaine loam.**—Well to excessively drained, this soil is developed principally in the Late Wisconsin glacial drift region and in small areas in the region of Early Wisconsin glaciation. Unlike the associated Miami, Crosby, and other soils developed on Late Wisconsin glacial drift, it is characterized by a calcareous gravel and sand substratum at a depth of 3 to 4 feet.

A total of 2,560 acres is mapped, principally on the scattered knolls or kames on the morainic areas in the vicinity of Greenwood, east, west, and south of Franklin, and along the bluffs of the valley of the White River southwest of Smith Valley. Region B on the soil association map (fig. 3) is predominantly of this type. The relief, often occurring as distinct ridges, is usually slightly steeper than that of surrounding areas. Both surface and internal drainage are good to excessive, the topographic position encouraging rapid surface runoff and the loose porous nature of the underlying material contributes to the somewhat excessive internal drainage. The native vegetation consisted chiefly of white and red oaks and hickory, with a few walnut, maple, elm, and other associated trees.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown friable granular loam, relatively low in organic content. Pebbles are numerous on the surface and throughout the layer, and an occasional boulder occurs on the surface. Reaction, slight to medium acid.

7 to 12 inches, light yellowish-brown to yellowish-brown friable coarse granular heavy loam to silt loam. Reaction, medium acid.

12 to 30 inches, yellowish-brown to weak reddish-brown waxy and gravelly clay loam, breaking into irregular-sized angular pieces, becoming hard when dry. Reaction, medium acid.

30 to 36 inches, dark yellowish-brown waxy and gravelly clay loam, breaking into angular pieces. This material changes abruptly from the above layer, and tongues or lenses extend into the underlying material. Reaction, slightly acid to neutral.

36 inches +, gray and yellow loose stratified calcareous gravel and sand. Cross bedding is usually prominent.

Variations in the profile characteristics are in the texture and thickness of layers and in the depth to the sand and gravel. Where the soil is very intimately associated with Miami silt loam or Miami loam, small areas of these soils are included with it on the soil map.

The common rotation consists of corn, wheat, and hay. In recent years, however, farmers are realizing the limitations of this soil, especially its moisture limitations and susceptibility to erosion, and are growing a larger proportion of small grains and alfalfa than formerly.

Corn usually follows hay in the rotation, yielding 25 to 35 bushels an acre under present management. Yields can be increased to 40 bushels or more under good management, which involves plowing under large quantities of organic matter, applying a sufficient quantity of commercial fertilizer, and growing less corn in the rotation. Wheat usually follows corn, and yields average 12 bushels an acre. It is commonly fertilized with 125 to 150 pounds of commercial fertilizer, and although not a common practice, some manure is used as a top dressing. Because of low moisture conditions during the growing season the soil is not adapted to growing oats, which average only 15 bushels an acre. Alfalfa is well adapted to this soil, good stands being obtained after sufficient lime is applied. Clover and other hay crops are not so well adapted as is alfalfa.

A good rotation system is a 4- to 5-year rotation of corn, wheat, and 2 to 3 years of alfalfa, which will aid in maintaining the organic and nitrogen content of the soil and help control erosion. Sufficient commercial fertilizer and manure when available should be used under corn and wheat crops to allow a surplus for the alfalfa.

**Bellefontaine loam, level phase.**—Although the profile characteristics are essentially the same as in the typical soil, the relief is nearly level to gently sloping. A total of 704 acres is mapped, principally on the flat tops of moraines and eskers just south of Franklin and in other small scattered areas in association with Bellefontaine loam and the Miami soils.

Management practices and crops grown are similar to those on the normal type, but the yields are usually slightly higher. Erosion is not a problem on this phase, and good tilth and fertility conditions are more easily maintained.

**Bethel silt loam.**—Developed on Late Wisconsin glacial drift, this light-colored very poorly drained soil has a gray or light-gray surface soil and a mottled subsoil and is more poorly drained than Crosby silt loam.

A total of 192 acres is mapped on small isolated areas associated with Crosby silt loam and Brookston silty clay loam. The larger areas are southeast of Rocklane and in the vicinity of Bargersville. The relief is nearly level and both external and internal drainage are slow. Most of the areas are, at present, sufficiently drained artificially to permit cultivation, but some areas need more adequate drainage.

Following is a profile description in cultivated areas:

0 to 7 inches, light-gray to gray friable granular silt loam, low in organic content. Small rust-brown or pale-yellow hard iron concretions are numerous on the surface and throughout the layer. In wooded areas the 2- to 3-inch surface layer is dark gray. Reaction, medium acid.

7 to 10 inches, light-gray to gray friable coarse granular heavy silt loam to silty

clay loam, with a few light-yellow blotches or spots and numerous iron concretions. Reaction, medium acid.

10 to 16 inches, gray, mottled and blotched with rust brown and pale yellow, gritty silty clay loam, containing small rust-brown iron concretions and variable quantities of grit, pebbles, and small rock fragments Reaction, medium to strongly acid.

16 to 36 inches, mottled gray, yellow, and rust-brown heavy plastic silty clay loam, breaking into ½- to 1½-inch subangular aggregates This material has a tendency to have ill-defined columnar structure, with a vertical axis 2 or 3 times the length of the horizontal axis. It is rather impervious to moisture movement and somewhat impervious to plant roots. Reaction, medium to strongly acid.

36 inches +, mottled gray, yellow, and rust-brown compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics are in texture and thickness of layers and in depth to calcareous till. Areas surrounded by or in close association with areas of Brookston silty clay loam have a somewhat darker colored surface soil than normal.

The soil is deficient in organic matter as well as most of the necessary plant nutrients, and any rotation system and management practice should include the plowing under of all available organic matter and the liberal use of commercial fertilizer.

Owing to the relatively low fertility and poor surface and internal drainage, much of this soil has remained in timber. The cleared areas are either under cultivation or in bluegrass pasture, although in seasons of abnormally high moisture conditions some areas are idle. Corn, wheat, and clover are the principal crops. Corn averages 25 bushels an acre and wheat 10. To obtain good yields it is necessary to maintain adequate artificial drainage, which in some instances is difficult to obtain on this soil because of the nearly level relief and the distance to outlets. Oats are not well adapted, as planting is often delayed in spring and, owing to the rapid drying out of the soil, the crop suffers from lack of moisture in summer. It is necessary to lime the soil for good stands of alfalfa and clover. These crops are, however, frequently severely damaged by winter-killing. Timothy is probably better suited to this soil than either clover or alfalfa.

**Brookston silty clay loam.**—This dark-colored soil of the "black and clay land" characterizes a large part of central Indiana. It has poor natural drainage conditions and occurs on broad flats or slight depressions in the regions of Wisconsin glacial drift, intimately associated with the Crosby, Fincastle, and other Early Wisconsin and Late Wisconsin drift soils.

This type is most extensive in the central and northern parts of the county, where it occupies rather large flats or slightly depressed areas. It also occurs throughout the Early Wisconsin and Late Wisconsin glacial drift regions as slight depressions that form a dendritic pattern, usually in close association with the other soils developed on this material. It is less extensive in the Early Wisconsin glacial drift region, often occurring at the heads of small drainageways. A total of 43,520 acres, or 21.1 percent of the county, is mapped and, together with Crosby silt loam, includes more than 47 percent of the area. Although both external and internal drainage are naturally poor, most areas have been artifically drained sufficiently to permit cropping. The native vegetation consisted of marsh grasses and water-tolerant trees, chiefly red maple, elm, black tupelo, and ash.

Following is a profile description in cultivated areas:

0 to 7 inches, dark-gray to very dark brownish-gray silty clay loam, relatively high in organic content. Reaction, neutral to slightly acid.

7 to 14 inches, dark-gray to dark brownish-gray silty clay loam to clay loam, with some light-yellow or rust-brown mottlings in the lower part, relatively high in organic content, and easily penetrated by roots. This material breaks into irregular-sized angular pieces, hard when dry but easily broken down when moist. Reaction, neutral.

14 to 48 inches, mottled gray, yellow, and rust-brown plastic gritty clay loam to sandy clay, containing an occasional boulder and various-sized rock fragments. This material breaks into large angular pieces, becoming hard when dry. Reaction, neutral.

48 inches +, mottled gray, yellow, and rust-brown clay loam to sandy clay calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments, representing the parent soil material.

Variations in profile characteristics are in texture and thickness of layers and depth to calcareous till. The shallower depressions and that part of the larger areas bordering the associated light-colored soils have silt loam to heavy silt loam surface textures. Some areas have a few inches of local wash on the surface from the surrounding areas. Areas associated with the Fincastle and Russell soils in the region of Early Wisconsin glaciation have slightly acid surface soils, which are somewhat lighter textured and contain less organic matter than those occurring in association with the Miami and Crosby soils in the regions of Late Wisconsin drift and the depth to calcareous till is usually greater.

More than 95 percent of this type is cleared of forest and either under cultivation or in permanent bluegrass pasture. Management practices and rotations are essentially the same as those on the associated light-colored soils of the Early Wisconsin and Late Wisconsin glacial regions. The rotation in common use includes corn, wheat or oats, and hay. Another common rotation includes corn, soybeans, wheat or oats, and 1 or more years of alfalfa. Although the fertilizer or plant nutrient requirements for most crops are somewhat different than on the associated light-colored soils, it is very difficult to treat areas of this silty clay loam in a different manner, unless a large part of a field unit consists of this type.

Corn usually follows hay or vegetables in the rotation. Where this soil comprises a large part of a field unit, corn is often grown for 2 or more consecutive years, yielding 45 to 60 bushels an acre. Under good management practices and favorable weather conditions, 70 bushels or more are not uncommon.

Wheat yields 15 to 25 bushels an acre, but there is some injury from winter-killing and from lodging of the grain (pl. 2, *A*). This crop is usually seeded in corn, or after soybeans or vegetables have been harvested, and is commonly fertilized with 100 to 150 pounds an acre of 2–12–6 or comparable commercial fertilizer mixture, although some farmers use a much higher application.

Oats yield 20 to 50 bushels an acre, often depending largely on weather conditions during the growing season. Some loss results from the lodging of the grain, owing to the high nitrogen and organic content of the soil. Very little fertilizer is used under oats, although some farmers apply rather large quantities at the time of seeding. Fertilizer is not applied especially for the direct benefit derived from increased oat yields, but because this is probably the best method of fertilizing hay crops, especially alfalfa and clover.

The soil is very well adapted to soybeans, which yield 20 to 30 bushels an acre, with higher yields not uncommon. They are grown for both

grain and hay, the recent increased acreage being largely for grain. Experiments have shown that yields are increased by indirect fertilization, which is accomplished by applying large quantities of fertilizer with small grains, corn, or other crops that precede soybeans in the rotation.

Excellent stands of alfalfa and clover may be secured without the use of lime, and yields usually are high. These crops, however, suffer some damage from winter-killing. Many farmers grow a mixture of alfalfa, clover, and timothy rather than alfalfa or clover alone.

Special crops, as sweet corn and tomatoes, are well suited to this soil. These crops, especially tomatoes, usually are rather heavily fertilized, and sweet corn yields 3½ to 5 tons an acre and tomatoes 8 to 10 tons.

**Carlisle silty muck.**—The only organic soil mapped in the county consists of an accumulation, in place, of plant remains, with enough silty mineral material in the surface soil to give it a silty texture.

A total of 192 acres of this type is mapped in the uplands, principally in the regions of Late Wisconsin glacial drift, occupying small isolated deeper depressional areas, usually in association with the Brookston and Clyde soils. The larger areas are in the vicinity of Hopewell and southeast of Needham. The native vegetation consisted of reeds, sedges, mosses, and marsh grasses, with some water-tolerant trees.

Following is a profile description in cultivated areas:

0 to 7 inches, very dark-gray to black silty muck, containing a considerable proportion of silty mineral material. Organic-matter content is very high; reaction, slightly acid.

7 to 15 inches, very dark-gray to black silty mucky material, breaking into thin plates and containing much less silty mineral material than the above layer.

15 inches +, brownish-yellow to pale-yellow macerated mucky and peaty material, consisting of partly decomposed plant remains. The material has a platy structure, and leaves, seeds and twigs are easily distinguished. Some areas are underlain below a depth of 36 inches by sand or clay.

The larger areas are used principally for corn, soybeans, and special crops. Where occurring in small areas associated with the Brookston, Clyde, and other soils, it is cropped about the same as the associated soils. It is very deficient in potash and moderately deficient in phosphate, therefore liberal quantities of these plant nutrients must be supplied to secure good crop yields. Adequate artificial drainage also is necessary for good crop yields, as drainage often becomes a problem. Vegetables, especially potatoes, are well suited to this soil, and excellent yields are obtained under good management, which includes the proper use of commercial fertilizer. Some areas are in permanent bluegrass pasture, having a good livestock-carrying capacity. A few areas are too wet for cultivation.

**Cincinnati silt loam.**—Developed on Illinoian glacial drift, this well-drained soil is similar to the Russell and Miami soils in natural drainage conditions but differs in the higher acidity of the surface soil and subsoil and the greater depth to calcareous till.

A total of 896 acres is mapped in the extreme southwestern part of the county on the glaciated part of the Norman upland physiographic division in association with Gibson and Avonburg silt loams. Region G of the soil association map (fig. 3) shows its location. The relief ranges from 2 to 12 percent, and surface drainage is good to excessive, surface runoff being excessive on the more sloping areas. The soil developed under a cover of deciduous trees, as red, black, and white oaks,

hickory, and maple, with some elm, ash, tuliptree (yellow-poplar), and other associated species.

Following is a profile description in cultivated areas:

0 to 7 inches, light grayish-brown to grayish-brown smooth friable silt loam, composed of firm but not hard medium-sized granules. The organic content is relatively low. In undisturbed wooded areas the 2- or 3-inch surface layer is dark yellowish brown to dark brownish gray. Reaction, strongly acid.

7 to 12 inches, yellowish-brown to brownish-yellow friable coarse granular heavy silt loam to silty clay loam, breaking into coarse granules or small subangular aggregates. The material is extremely silty and uniform in character, contains few pebbles, and is permeable to moisture movement and plant roots. Reaction, strongly acid.

12 to 20 inches, yellowish-brown to brownish-yellow silty clay loam, breaking into ¼- to ¾-inch subangular aggregates. A thin coating of gray colloidal material is present on many of the cleavage faces. This horizon is permeable to moisture movement and to plant roots. Reaction, strongly acid.

20 to 40 inches, brownish-yellow silty clay loam, breaking into ¾- to 1½-inch subangular aggregates that are hard when dry but easily broken down when moist. A few pebbles of quartz and other exotic rocks are in the lower part of this layer. The material is permeable to moisture movement and plant roots. At a depth of 30 to 36 inches, some areas have a rather compact layer about 12 inches thick. When this is present the material is somewhat impermeable to moisture movement and plant roots. Reaction, strongly acid.

40 to 120 inches, brownish-yellow silty clay loam, with streaks of light yellow, gray, and rust brown in the lower part. The material is somewhat more friable than the above layer, breaking into subangular aggregates, easily broken down into coarse granules. Pebbles and rock fragments are numerous in the lower part. Reaction, strongly acid in the upper part, slightly acid in the lower part.

120 inches +, gray and yellow compact glacial till, composed of unassorted silt, clay, sand, and rock fragments.

Variations from profile characteristics just described are in the texture and thickness of layers and the depth to calcareous till. Included are a few moderately sheet-eroded areas, where a part of the surface soil has been removed by accelerated erosion, exposing the heavier textured brownish-yellow to yellowish-brown subsurface soil.

Most areas of this soil have been cleared and cultivated, but because of its susceptibility to erosion and declining fertility, probably less than 25 percent is at present under cultivation. A large part is idle or abandoned land, having a cover of broomsedge, poverty oatgrass, and various weeds, with a scattering of briers and sassafras. The common rotation system includes corn, wheat or rye, and hay consisting chiefly of timothy, redtop, and some clover.

Corn, probably the most extensive crop grown, usually follows hay. Average yields of 25 bushels an acre under present management may be materially increased under good practices, which include turning under all available organic matter, liming to correct acidity, applying liberal quantities of commercial fertilizer, and growing less corn and more hay crops, especially clover. Wheat is probably the second most important crop grown. It is not so commonly fertilized on this soil as on Russell and Miami silt loams. Under prevailing management practices, it yields 10 to 15 bushels, but may yield as much as 20 or more under good practices. Oats, not well adapted to this soil, are not extensively grown. They yield 20 to 35 bushels an acre.

Hay includes some clover alone and a mixture of timothy, redtop, and clover, with some lespedeza. Applications of sufficient lime (3 to 4 tons an acre) are necessary for the successful growing of clover. Although some farmers attempt to grow alfalfa, it is doubtful whether it can be

successfully grown over an extended period, owing to the high acidity of the surface soil and subsoil.

**Cincinnati silt loam, eroded phase.**—This phase, covering a total of 1,024 acres, occurs on slopes of more than 10 percent in association with the typical soil and its various other phases in the Illinoian glacial drift region. A large part of the surface soil and a part of the subsoil have been removed by accelerated erosion. The heavier textured subsoil is mixed with the surface soil in cultivation, and in numerous areas it is exposed.

The removal of a large part of the surface soil has resulted in the loss of a large quantity of plant nutrients, lowered fertility and tilth and materially reduced crop yields. All this phase has been cleared and brought under cultivation, but at present a large part is abandoned and supports a growth of broomsedge, poverty oatgrass, briers, and sassafras.

**Cincinnati silt loam, shallow phase.**—Though similar to the normal type in relief, drainage, and profile characteristics of the surface and upper subsoil layers, this phase is underlain at a depth of 3 to 7 feet by bedrock of sandstone, siltstone, and shale. Only 128 acres is mapped.

Management practices and crops grown are about the same as those on the typical soil, but crop yields usually are slightly lower, especially in areas where bedrock is close to the surface. Erosion is somewhat greater on this phase than on the typical soil. Much of this phase has been taken out of cultivation and at present is idle or abandoned land, supporting a growth of broomsedge, poverty grass, and various weeds, with a scattered growth of briers and sassafras.

**Cincinnati silt loam, steep phase.**—Except for its thinner layers, this phase has essentially the same profile characteristics as the normal soil. It occurs on slopes of 12 to 40 percent or more, covering a total of 1,664 acres. A large part is in forest, chiefly white, red, and black oaks, and hickory. Less than 15 percent is now under cultivation, chiefly to corn and wheat. Numerous abandoned areas now support a growth of broomsedge, poverty oatgrass, and sassafras. Because of susceptibility to erosion, this phase is better adapted to forest than to cultivated crops.

**Clyde silty clay loam.**—This is a very dark-colored poorly drained soil, occupying rather small areas of the deeper depressions in association with Brookston silty clay loam, principally in the central and northern parts of the county in the regions of Late Wisconsin glaciation. A few small areas occur in the regions of Early Wisconsin drift. A total of 256 acres is mapped.

Natural drainage is very poor, but the greater part of the soil is artificially drained sufficiently to permit cropping. In seasons of abnormally high rainfall, however, crops are drowned out, or the areas are not cropped. The native vegetation consisted of marsh grasses and water-loving trees. Several undrained areas at present have a growth of sycamore and marsh grass.

Following is a profile description in cultivated areas:

0 to 7 inches, very dark-gray to nearly black silty clay loam, relatively high in organic matter. Reaction, neutral.

7 to 18 inches, dark-gray to very dark-gray gritty silty clay loam to clay loam, relatively high in organic matter. An occasional large boulder is present, and the content of sand and fine gravel is variable. The material breaks into angular pieces that become hard when dry. Reaction, neutral.

18 to 28 inches, light-gray to gray heavy plastic clay loam or sandy clay with light-yellow or rust-brown mottlings in the lower part. The material usually contains much grit and rock fragments. Reaction, neutral.

28 to 50 inches, mottled gray, yellow, and rust-brown clay loam to sandy clay, breaking into large angular pieces. The material is plastic when moist and becomes very hard when dry. Reaction, neutral.

50 inches +, mottled gray, yellow, and rust-brown compact calcareous glacial till, consisting of unassorted silt, clay, sand, and rock fragments.

Variations from the profile characteristics are in texture and thickness of layers and in depth to calcareous till. A few areas in the deeper depressions, especially in association with the larger areas of Brookston silty clay loam, have silty clay surface soils. Some undisturbed areas may have a few inches of silty muck on the surface.

Areas of this soil having adequate artificial drainage are cropped about the same as Brookston silty clay loam. Corn yields are about equal to or slightly higher than those obtained on the Brookston soil in years of normal rainfall, but during years of abnormally high rainfall it is not uncommon for the crop to be drowned out. Thus, the average yield over a period of years is somewhat lower than that obtained on the Brookston type.

Wheat, oats, and other small grains are frequently grown but are often severely damaged by winter-killing or drowning out.

Applications of lime are not necessary to secure good stands of clover and alfalfa, but damage to these crops from winter-killing is occasionally severe.

**Crosby silt loam.**—Developed throughout the regions of Late Wisconsin glacial drift in close association with the Brookston, Miami, Bethel, and Clyde soils, this imperfectly drained light-colored soil of the "black and clay land," typical of a large part of central Indiana, is the most extensive type mapped, covering a total of 53,760 acres, or 26.1 percent of the county area. It is only 1 to 2 feet above areas of Brookston silty clay loam, the gradation to which is gradual. The relief is nearly level to gently undulating. Natural drainage is imperfect, but most areas are artificially drained sufficiently to permit cultivation. Native vegetation consisted chiefly of sugar maple and beech, with lesser quantities of elm, ash, sweetgum, black tupelo, white oak, and black oak.

Following is a profile description in cultivated areas:

0 to 7 inches, light brownish-gray friable granular silt loam, containing varying quantities of grit and small pebbles. The material is composed of firm, but not hard, easily crushed medium-sized granules. The organic-matter content is variable, though usually low. In undisturbed wooded areas the 2- to 3-inch surface layer is dark brownish gray, relatively high in organic matter. Reaction, slight to medium acid.

7 to 10 inches, light brownish-gray friable silt loam, breaking into coarse granular aggregates. Reaction, medium acid.

10 to 15 inches, mottled gray, yellow, and rust-brown heavy silt loam to silty clay loam, breaking into ¼- to ½-inch subangular or nuciform aggregates that are easily broken down into coarse granules. Numerous pebbles and an occasional boulder are present. Reaction, medium acid.

15 to 36 inches, mottled gray, yellow, and rust-brown gritty silty clay loam, breaking into ½- to 1½-inch subangular aggregates. This layer is somewhat impervious to moisture movement. Reaction, medium acid.

36 inches +, mottled gray, yellow, and rust-brown compact calcareous till composed of unassorted silt, clay, sand, and rock fragments, representing the parent soil material.

Variations in the profile characteristics are in the texture and thickness of layers and the depth to calcareous till. Where this soil grades into

Brookston silty clay loam, the surface soil usually is somewhat darker colored and slightly heavier textured. The reaction of the surface soil and subsoil in a few areas is only slightly acid.

Practically all this soil is under cultivation or in bluegrass pasture, less than 5 percent remaining in forest. It is cropped about the same as Brookston silty clay loam. A common rotation includes corn, wheat or oats, and hay. Also in rather common use is a rotation of corn, soybeans, wheat or oats, and 1 to 3 years of alfalfa. These rotations are varied to include field crops, as rye, timothy, and other hay crops, and special crops, as tomatoes and sweet corn. When hay crops fail or wheat is winterkilled, the rotation is adjusted to take care of this condition.

A large part of this soil is used for corn, which averages 35 bushels an acre under prevailing management practices (pl. 2, *B*). Owing to the relatively low organic content of the surface soil, it is essential that manure and other crop residue be turned under to maintain and increase tilth conditions. Under good management, which involves turning under large quantities of organic matter, applying sufficient quantities of commercial fertilizer, and including more clover and alfalfa and less corn and soybeans in the rotation, corn yields 50 bushels or more an acre. Wheat is usually fertilized with 100 to 150 pounds of 2-12-6, and yields average 15 bushels an acre. Winter-killing occasionally causes severe damage to this crop. Oats yield 20 to 50 bushels an acre, depending largely on weather conditions during the growing season. Very little fertilizer is used under oats. A few farmers, however, apply relatively large quantities of fertilizer at the time of seeding, as a fertilizer for clover or alfalfa rather than for the benefits derived by the oats.

Alfalfa and clover can be successfully grown after additions of lime to the soil (1 to 2 tons an acre). These crops are often grown with a mixture that includes timothy, alsike, and occasionally bromegrass. When grown alone, alfalfa is often allowed to remain for 2 years or more. Soybeans yield 15 to 30 bushels an acre, depending on seasonal conditions and fertility of the soil. They are not commonly fertilized, but a few farmers plow under fertilizer before sowing beans, or apply large quantities under corn, small grains, or other crops that precede beans in the rotation.

Special crops, especially sweet corn and tomatoes, are rather extensively grown, predominantly in the northern part of the county and in areas adjacent to canning factories. Tomatoes usually receive large quantities of fertilizer, but the yields generally are somewhat lower than on Brookston silty clay loam.

**Delmar silt loam.**—Developed on Early Wisconsin glacial drift, this very poorly drained light-colored soil is similar to Bethel silt loam in drainage conditions, but differs in the lack of grit and pebbles in the surface soil and upper subsoil, in the greater acidity, and in the depth to calcareous till. This type occurs in small isolated areas associated with the Fincastle, Brookston, and other soils in the regions of Early Wisconsin glacial drift. Only 64 acres are mapped. The relief is nearly level, and surface and subsoil drainage conditions are naturally very poor. The native vegetation consisted chiefly of elm, ash, sycamore, and white oak.

Following is a profile description in cultivated areas:

0 to 7 inches, light-gray to gray smooth friable medium-granular silt loam, relatively low in organic content. The 2- to 3-inch surface layer in undisturbed wooded areas is dark gray and relatively high in organic matter. Numerous

small rounded pale-yellow or rust-brown iron concretions are present. Reaction, medium acid.

7 to 10 inches, light-gray to gray friable smooth heavy silt loam to silty clay loam, containing numerous small rounded iron concretions and is composed of medium-sized firm but not hard granules. Reaction, medium to strongly acid.

10 to 18 inches, mottled gray, yellow, and rust-brown silty clay loam, containing very little grit or pebbles and breaking into small subangular aggregates, easily broken down when moist into coarse granules. Reaction, medium to strongly acid.

18 to 36 inches, mottled gray, yellow, and rust-brown plastic heavy clay loam, usually breaking into 1- to 1½-inch subangular particles but in some areas having ill-defined columnar structure with the length of the vertical axis 2 to 3 times that of the horizontal. The upper part usually contains very little grit or pebbles, but the lower contains varying quantities of grit, pebbles, and rock fragments. It is somewhat impervious to moisture movement and to plant roots. Reaction, strong to medium acid.

36 to 45 inches, mottled gray, yellow, and rust-brown silty clay loam, somewhat more friable than the above layer and less impervious to moisture movement and plant roots. This material breaks into medium-sized subangular aggregates and contains numerous small rock fragments and an occasional boulder. Reaction, medium to slightly acid.

45 inches +, gray and yellow compact calcareous glacial till composed of unassorted silt, clay, and rock fragments, representing the parent soil material.

Variations in the profile characteristics are in texture and thickness of horizons and in depth to calcareous till.

This soil is cultivated to about the same crops as the associated Fincastle silt loam, but owing to very poor natural drainage and low fertility, yields are materially lower. Its occurrence in small rather isolated areas, in close association with Fincastle silt loam, prohibits special treatment of this soil.

Depending on adequacy of artificial drainage and state of soil fertility, corn yields average 20 to 30 bushels an acre. In sufficiently artificially drained areas where the fertility has been increased by the addition of a large quantity of crop residue and the liberal use of a commercial fertilizer, acre yields may approach 40 bushels or more.

The soil is not well adapted to growing small grains, as wheat, rye, and oats. Considerable damage to wheat and rye results from winter-killing. As this soil dries out very slowly in spring, the planting of oats is often delayed and its rapid drying out in summer may cause the crop to suffer from lack of moisture. Wheat and rye average 10 bushels an acre and oats, 20 bushels.

Alfalfa and clover can be successfully grown after sufficient lime has been applied and adequate artificial drainage has been installed. Serious damage to these crops by winter-killing or heaving is not uncommon. Timothy is probably better adapted than clover and alfalfa, but many farmers use a mixture of timothy, clover, alsike, and alfalfa.

**Eel loam.**—Moderately well-drained to imperfectly drained, this soil is similar to Eel silt loam in profile characteristics, except that the surface texture is loam, the upper subsoil contains more sand, and the lower subsoil contains layers or strata of sand and gravel. A total of 384 acres is mapped in the flood plains of the rivers and streams throughout the regions of Wisconsin glaciation, especially along Sugar Creek and the small drainageways. Management practices and the rotation are about the same as on Eel silt loam; corn is the principal crop grown, and crop yields are about the same as those on that soil.

**Eel silt loam.**—Developed on sweet alluvium washed from regions of Wisconsin glacial drift and glaciofluvial outwash plains and terraces,

this moderately well-drained to imperfectly drained soil occupies the flood plains of the rivers and streams throughout the regions of Wisconsin glaciation. It occurs in temporary channels made by floodwaters and is often the dominant soil along small drainageways. An aggregate area of 7,296 acres is mapped. The elevation generally is a few feet lower than that of the associated Genesee and Ross soils. Native vegetation consisted chiefly of sycamore, elm, and ash.

Following is a profile description in cultivated areas:

0 to 7 inches, light grayish-brown to brownish-gray friable granular silt loam. The organic-matter content is variable, but usually low. Reaction, neutral.

7 to 20 inches, light brownish-yellow friable coarse granular heavy silt loam to silty clay loam, having a somewhat platy structure. An occasional thin layer of fine sand is present. Reaction, neutral.

20 inches +, mottled gray, yellow, and rust-brown silty clay loam to sand and gravel. There is a wide variation in the composition of this material, and numerous depositional layers can be distinguished. Below a depth of 40 inches the material is chiefly sand and gravel. Reaction, neutral to calcareous.

Variations in profile characteristics are in color, texture, and thickness of layers.

It is estimated that between a third and a half of this soil is at present under cultivation, and the rest is in permanent bluegrass pasture or forest. Corn is the principal crop, and yields average about 50 bushels an acre. Except where this soil occurs intimately associated with the Genesee and Ross soils, oats and wheat are not so intensively grown as on those soils, because of the danger from flooding and drowning out. Alfalfa is well suited, but damage from flooding is occasionally severe.

**Eel silty clay loam.**—Occurring on the flood plains in the regions of Wisconsin glaciation, this moderately well-drained to imperfectly drained soil is similar to Eel silt loam in profile characteristics, except that it has a silty clay loam surface soil and a heavier textured subsoil that contains less gravel and sand. A total of 2,176 acres is mapped in the temporary channels made by floodwaters in the wider bottoms, and along numerous streams and drainageways.

A larger part of this soil than of Eel silt loam is cleared and cultivated. Corn, the principal crop grown, yields about 50 bushels an acre. Wheat is an important crop, owing to the occurrence of the soil in the larger bottoms in long narrow areas closely associated with the Genesee soils, and yields average about 15 bushels an acre. Damage from flooding is occasionally severe. Clover and alfalfa can be successfully grown without the use of lime, but severe loss occasionally results from flooding and heaving.

**Fincastle silt loam.**—Developed on unassorted Early Wisconsin glacial drift, this light-colored, imperfectly drained soil is similar to Crosby silt loam in drainage conditions but differs in having smooth silty surface and upper subsoil layers and in being relatively free of grit and pebbles, stronger in acidity of the surface soil and subsoil, and greater in depth to calcareous till. Lime carbonates have been leached to a depth of 40 to 48 inches, the average being about 46 inches.

A total of 2,624 acres of this soil occurs in the southwestern part of the county in association with the Russell, Delmar, Brookston, Bellefontaine, and Clyde soils. Occupying a position intermediate between areas of the Russell and Brookston soils, the relief is nearly level to gently undulating, and internal drainage, therefore, is slow in most areas. Owing to the imperfect internal drainage, it is necessary to drain the

soil artificially, generally with tile drains, to insure good crop yields. Most of the areas have been artificially drained sufficiently to permit cultivation, but some areas need more adequate drainage. The native vegetation consisted principally of beech, sugar maple, elm, sweetgum, black tupelo, and white, black, and pin oaks.

Following is a profile description in cultivated areas:

0 to 7 inches, light brownish-gray smooth friable granular silt loam, relatively low in organic content. In undisturbed wooded areas the 1- to 2-inch surface layer is dark brownish gray and relatively high in organic content. Reaction, medium acid.

7 to 10 inches, light brownish-gray grit-free friable heavy silt loam to silty clay loam, with a few light-yellow mottlings. The material is composed of firm but not hard medium to coarse granules, with very little grit and pebbles present. Reaction, medium to strongly acid.

10 to 16 inches, mottled gray, yellow, and rust-brown grit-free silty clay loam, breaking into ¼- to ¾-inch subangular aggregates. Only a small quantity of grit and pebbles is present. Reaction, medium to strongly acid.

16 to 35 inches, mottled gray, yellow, and rust-brown heavy plastic silty clay loam, breaking into ¾-inch to 1½-inch subangular aggregates. This layer is somewhat impermeable to moisture movement and plant roots. Reaction, strong to medium acid.

35 to 46 inches, mottled gray, yellow, and rust-brown silty clay loam containing increasing quantities of grit, pebbles, and rock fragments with depth. This layer is more friable than the one above and not so impermeable to moisture movement and plant roots. Reaction, medium to slightly acid.

46 inches +, gray and yellow compact calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments. This represents the parent material.

Variations in the profile characteristics are in texture and thickness of layers and depth to calcareous till. Where this soil grades into Brookston silty clay loam, the surface soil is somewhat darker colored and slightly heavier textured than typical.

The greater part of the soil has been cleared of timber and is either cropped or in bluegrass pasture. Management practices and rotation are similar to those on Crosby silt loam, and crop yields are comparable. The somewhat more acid surface soil and subsoil, however, require the application of more lime for the successful growing of clover and alfalfa, which are necessary in the rotation to maintain and increase the organic content and tilth conditions. The common rotation includes corn, wheat, and hay Soybeans, oats, rye, and other field crops are fitted into the rotation, and sweet corn, tomatoes, and other special crops are grown.

Corn usually follows hay in the rotation, or it may follow other crops, especially when wheat or rye has been winterkilled. Under prevailing management practices, corn is generally fertilized with 60 to 150 pounds of commercial fertilizer and yields 30 to 40 bushels an acre. Acre yields may be increased to 50 bushels under good management, which involves applying liberal quantities of manure, sufficient quantities of commercial fertilizer, and including less corn and more clover and alfalfa in the rotation. Oats are not so extensively grown as on Crosby silt loam. Yields (20 to 50 bushels an acre) are greatly influenced by weather conditions. Very little commercial fertilizer is used under oats. A few farmers, however, make heavy applications of fertilizer at the time of seeding, for the purpose of fertilizing the clover or alfalfa crop rather than for the benefits derived from the increased yields of oats.

Alfalfa and clover may be successfully grown after sufficient applications of lime (1 to 3 tons an acre), and best results are obtained when

phosphate and potash fertilizer is used. It is a rather common practice to include alfalfa and clover in a hay mixture of timothy, alsike, and occasionally bromegrass. Soybeans yield 15 to 25 bushels an acre, but larger yields may be expected under better management practices. Experiments have shown that yields can be materially increased by plowing under a rather heavy application of commercial fertilizer prior to the seeding of soybeans.

Special crops, as sweet corn and tomatoes, are not so extensively grown as on Crosby silt loam, but yields are about the same.

**Fox loam.**—Occurring on the glaciofluvial outwash plains and terraces, this soil is the well to excessively drained member of the catena that includes the Homer, Westland, and Abington soils and is underlain by loose stratified gravel and sand.

A total of 6,208 acres is mapped in the valleys of the White and Blue Rivers in the northwestern and southeastern parts of the county, respectively, and to a lesser extent in the valleys of the smaller streams, in association with the Homer, Westland, Abington, Martinsville, and Nineveh soils. This type usually occupies a position intermediate between areas of alluvial soils and those of the Wisconsin glacial uplands. Some rather large bodies are several feet above the flood plains. The relief is nearly level to gently undulating.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown friable medium-granular gritty loam, relatively low in organic matter. In undisturbed wooded areas the 2- or 3-inch surface layer is dark brownish gray to dark yellowish brown. The content of sand and fine gravel is variable, and an occasional large boulder is present. Reaction, medium to slightly acid.

7 to 12 inches, light yellowish-brown to yellowish-brown friable coarse granular heavy loam to silty clay loam. This layer is permeable to moisture movement and plant roots. Reaction, medium acid.

12 to 20 inches, yellowish-brown sandy clay loam, breaking into small angular aggregates, easily crushed when moist but hard when dry. This layer is permeable to moisture movement and plant roots. Reaction, medium acid.

20 to 34 inches, yellowish-brown to weak reddish-brown waxy gravelly clay loam, containing numerous rounded glacial gravel. The material breaks into angular pieces, sticky and plastic when wet and hard when dry. Reaction, medium acid.

34 to 38 inches, dark-brown to dark brownish-gray waxy gravelly heavy clay loam, containing numerous rounded glacial gravels and an occasional boulder. The material breaks into large angular pieces, plastic and sticky when moist but hard when dry. There is an abrupt change from the above layer to this material and from this to the underlying material. Tongues or lenses of this layer extend into the underlying material. Reaction, slightly acid to neutral.

38 inches +, gray and light-yellow loose calcareous stratified gravel and sand, containing a high percentage of limestone.

Variations in the profile characteristics are in texture and thickness of layers and in depth to the underlying gravel and sand. The dark-brown to dark brownish-gray layer immediately above the gravel is extremely variable in thickness. It may be only an inch or two thick in a few areas.

A rotation system that includes corn, wheat, and hay is in general use, but one of corn, soybeans, wheat, and alfalfa 2 or more years also is practiced. These rotations are varied to conform to individual requirements and to weather and economic conditions. Hay often includes a mixture of clover, alfalfa, and timothy.

Corn averages 30 bushels an acre. Yields can be increased, however, under improved management practices, which involve turning un-

der all available organic matter, correcting soil acidity by applying sufficient lime (1 to 2 tons an acre), and growing more hay, especially alfalfa. It is a common practice to use 50 to 150 pounds of commercial fertilizer an acre under corn, and a few farmers use larger quantities. Wheat usually follows corn in the rotation. Yields average 20 bushels an acre under prevailing practices and can be increased materially under good management. It is commonly fertilized with 100 to 150 pounds of commercial fertilizer an acre. Because of low moisture conditions during the growing season, the soil is not well suited to growing oats, yields of which are usually low.

Alfalfa is well suited to this soil, good stands being obtained after soil acidity has been corrected. Clovers are not so well adapted as alfalfa and generally are used as part of a hay mixture that also includes timothy and alfalfa. Sweetclover is occasionally grown as an intercrop. It is sown in wheat in spring, turned under the following spring, and the land planted to corn.

Special crops—tomatoes, sweet corn, and canning peas—are grown to a limited extent, especially in the vicinity of Edinburg. With proper fertilization and favorable weather conditions they produce good yields.

**Fox loam, sloping phase.**—With the exception of thinner layers and larger content of gravel in the surface soil, this phase has essentially the same profile characteristics as the normal soil. A total of 512 acres is mapped on the narrow slopes of 10 to 30 percent or more between areas of Fox loam and the associated alluvial soils and between terrace levels. Sheet erosion is moderately severe over much of the area and severe in some places. In eroded areas the surface soil is heavy loam to clay loam, very low in organic matter, and the heavy subsoil is exposed.

This soil is not so intensively cultivated as the normal type, and some slopes are in alfalfa for several successive years or in bluegrass pasture. Owing to its low fertility, crop yields are lower than on the typical soil. A few areas remain in forest.

**Fox silt loam.**—The well-drained member of the catena that includes the Homer, Westland, and Abington soils, this soil has essentially the same profile characteristics as Fox loam, except for the silt loam surface soil, the heavier and thicker subsoil, and the greater depth to the underlying gravel and sand. The material was deposited by waters from the receding Wisconsin glacier, and the underlying gravel and sand is assorted and stratified.

An aggregate area of 1,344 acres is mapped, more extensively on the terraces and outwash plains in the valleys of the Blue River and Sugar Creek and to a lesser extent in the valley of the White River and adjacent to the smaller streams in the regions of Wisconsin glaciation. It occurs 10 to 15 feet or more above the alluvial soils. Surface runoff is slight, and internal drainage is good. The native vegetation consisted chiefly of black and red oaks, maple, walnut, hackberry, and ash.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown friable medium-granular silt loam, relatively low in organic matter. In undisturbed wooded areas the 2- to 3-inch surface soil is dark gray and relatively high in organic matter. Reaction, medium to slightly acid.

7 to 12 inches, light yellowish-brown to yellowish-brown heavy silt loam to silty clay loam, breaking into coarse granules or small subangular aggregates. This layer is permeable to moisture movement and plant roots. Reaction, medium acid.

12 to 20 inches, yellowish-brown silty clay loam, breaking into ¼- to ¾-inch subangular aggregates. This material contains some small glacial gravels. Reaction, medium acid.

20 to 40 inches, yellowish-brown to weak reddish-brown waxy and gravelly plastic clay loam, breaking into irregular-shaped angular pieces. This material is plastic when moist, sticky when wet, and hard when dry. It is slightly impermeable to moisture movement and plant roots. Reaction, medium acid.

40 to 45 inches, dark yellowish-brown to dark brownish-gray waxy and gravelly heavy clay loam, breaking into large angular pieces. There is an abrupt change from the above layer to this material and from this layer to the underlying material. Tongues or lenses extend downward into the underlying layer. Reaction, slightly acid to neutral.

45 inches +, gray and light-yellow loose stratified calcareous gravel and sand.

Variations in profile characteristics are in texture and thickness of the layers and in depth to calcareous gravel and sand.

The crop rotations are about the same as on Fox loam, with corn, wheat, and hay the principal crops. This is varied to include soybeans and special crops, as tomatoes, sweet corn, and canning peas.

Corn usually follows hay, averaging 35 bushels an acre under the prevailing management. Higher yields are obtained when better management practices are used. Most farmers use some fertilizer (50 to 150 pounds or more an acre) for corn. Wheat is better adapted to this soil than to Fox loam, as moisture relations are better, and the average yield of 20 bushels an acre can be increased by using 100 to 150 pounds of commercial fertilizer an acre. Oats are not well adapted to this soil, and only a small total acreage is grown.

Hay generally includes a mixture of clover, alfalfa, and timothy, with some alsike and sweetclover, but clover and alfalfa are also grown alone. Alfalfa is better suited than either clover or timothy, and good stands can be obtained when the soil acidity has been corrected by applications of lime. Clover, better adapted to this soil than to Fox loam, can be successfully grown after applying sufficient lime. There is, however, some loss from drought.

**Genesee fine sandy loam.**—This well-drained soil on sweet alluvium washed from regions of Wisconsin glaciation and glaciofluvial outwash plains and terraces differs from Genesee silt loam and loam in having a fine sandy loam surface soil and a lighter textured subsoil. Stratified layers of sand and gravel are common below a depth of 36 inches.

Only 192 acres are mapped, principally in the valleys of the White River and Sugar Creek, chiefly as natural levees to the present streams or along old ox bows. It is less extensively cultivated than either Genesee silt loam or loam because of low fertility, more limited moisture supply, and greater danger of crop loss from stream cutting. Corn, the principal crop grown, averages about 35 bushels an acre. Wheat and other small grains are grown only to a limited extent. Alfalfa is well adapted, but there is danger of loss from flooding. Special crops, as melons and early tomatoes, can be satisfactorily grown, but only a few areas are used for them. A considerable part of the soil is in permanent bluegrass pasture and forest.

**Genesee loam.**—Differing from Genesee silt loam, this well-drained soil on sweet alluvium washed from regions of Wisconsin glaciation and glaciofluvial outwash plains and terraces has a loam surface soil and a coarser textured subsoil. It occurs on the flood plains of the rivers and streams throughout the Wisconsin glaciated regions, often in large bodies. An aggregate area of 2,688 is mapped. Management practices,

crops grown, and yields are about the same as on the silt loam, but a slightly larger part is in permanent bluegrass pasture and forest.

**Genesee silt loam.**—This is a well-drained soil on sweet alluvium from regions of Wisconsin glacial drift and glaciofluvial outwash plains and terraces. A total of 7,424 acres occurs on the flood plains of the rivers and streams throughout the Wisconsin glacial region, the larger areas being adjacent to the White and Blue Rivers and Sugar Creek. It often covers rather extensive areas, and numerous field units are composed largely or entirely of this soil. Drainage is good, although all areas are subject to overflow during periods of extremely high water and a large part is flooded an average of at least once a year. Native vegetation consisted chiefly of sycamore, elm, Carolina poplar, and ash.

Following is a profile description in cultivated areas:

0 to 7 inches, yellowish-brown to light yellowish-brown friable medium granular silt loam. The organic content is variable but usually relatively low. Reaction, neutral to slightly alkaline.

7 to 30 inches, yellowish-brown to brownish-yellow friable granular heavy silt loam to silty clay loam, having a platy structure, with thin layers of fine sandy material present. Reaction, neutral to slightly alkaline.

30 inches +, yellowish-brown to brownish-yellow silty clay loam to sand. The texture is extremely variable and depositional layers can be easily recognized.

Variations in the profile characteristics are in texture and thickness of layers. In areas adjacent to Ross silty clay loam the surface soil generally is darker colored than normal. Partly decomposed leaves, branches, twigs, and other organic debris occur in various depositional layers throughout the profile.

The greater part of this soil is at present under cultivation. Corn and wheat are the principal crops, although soybeans, alfalfa, and special crops are also rather extensively grown. The rotation system, which is extremely variable, is influenced by the size of the areas and their location in relation to canning factories and markets, and by the economic conditions and size of the farm unit. Corn is often grown for 2 or more consecutive years, followed by wheat or soybeans, and then by corn for 2 or more years. When tomatoes, sweet corn, canning peas, and other special crops are grown, they are usually followed by wheat or corn. Some farmers sow sweetclover in wheat in spring, turn it under the following spring, and plant the land to corn.

Corn yields 40 to 90 bushels or more an acre and averages about 55 bushels. The higher yields are obtained when weather conditions are most favorable, and when better management practices are used, which involve growing clover and alfalfa and applying sufficient commercial fertilizer of proper analyses. It is a rather common practice to use 50 to 150 pounds or more of commercial fertilizer an acre for corn. Wheat is well adapted to this soil, yielding 18 to 25 bushels an acre, but there is always potential danger from floodwaters, especially during early spring. Acre applications of 100 to 150 pounds of commercial fertilizer are used for wheat. Oats, grown to a limited extent, generally take the place of wheat in the rotation, averaging about 40 bushels an acre. Excellent stands of clover and alfalfa can be obtained without applying lime, but loss from floodwaters is occasionally severe. Vegetables are extensively grown in some areas and yields are good, expecially when properly fertilized.

**Gibson silt loam.**—Developed on Illinoian glacial drift, this type is moderately well drained, being intermediate in drainage conditions between soils of the Cincinnati and Avonburg series.

Occurring in the southwestern part of the county associated with Cincinnati silt loam and its various phases and with Avonburg silt loam, this soil forms a part of region G on the soil association map (fig. 3). The relief is nearly level to gently undulating, the slopes usually being less than 3 percent. External drainage is good to somewhat slow on the more nearly level areas, and internal drainage is good in the upper part and somewhat restricted in the lower. The native vegetation consisted of a mixed growth of hardwoods, chiefly white, red, and black oaks, hickory, beech, and maple.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown to brownish-gray smooth friable medium granular silt loam, relatively low in organic content. In undisturbed wooded areas the 2- or 3-inch surface layer is dark gray. Reaction, strongly acid.

7 to 12 inches, light yellowish-brown to light brownish-yellow friable smooth heavy silt loam to silty clay loam, composed of firm but not hard easily crushed coarse granules This layer is permeable to moisture movement and plant roots Reaction, strongly acid

12 to 20 inches, light brownish-yellow grit-free silty clay loam, breaking into coarse granules to small subangular aggregates. The material is permeable to both water movement and plant roots Reaction, strongly acid.

20 to 30 inches, mottled gray, yellow, and rust-brown heavy silty clay loam, breaking into ½- to 1½-inch subangular aggregates Very little grit or pebbles are present. The material is permeable to moisture movements and plant roots. Reaction, strongly acid.

30 to 42 inches, mottled gray, yellow, and rust-brown heavy silty clay loam, breaking into large subangular pieces or into ill-defined columns having a vertical length 3 or 4 times that of the horizontal and a capping of light-gray silty material. This layer is somewhat impervious to moisture movement and to plant roots. Reaction, strong to very strongly acid

42 to 120 inches, mottled gray, yellow, and rust-brown silty clay loam, somewhat friable and breaking into subangular pieces that are easily crushed when moist. The quantity of grit, pebbles, and rock fragments increases with depth. Reaction, strongly acid in the upper part and slightly acid in the lower.

120 inches +, gray and yellow compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments.

Variations in profile characteristics are in texture and thickness of layers and in depth to calcareous till. The heavy siltpan layer that usually occurs at a depth of about 30 inches is occasionally absent. A few areas on gently undulating relief, usually at the heads of small drainageways, have moderately accelerated sheet erosion.

The greater part of this soil has been cleared and brought under cultivation. The common rotation includes corn, wheat, and hay, principally timothy and clover, with some redtop. More hay, especially clover, and less corn are essential to maintain and increase the soil productivity.

Corn averages 25 bushels an acre under present practices but this can be materially increased under good management, which involves plowing under all available organic matter and crop residue, correcting strong acidity, and including more clover and other legumes and less clean-cultivated crops in the rotation. Corn is not commonly fertilized, although some farmers apply 50 to 150 pounds an acre of commercial fertilizer. Wheat yields average 12 bushels under prevailing practices, but under good management this can be increased to 20 bushels or more. A mixture of timothy, clover, and redtop, or timothy or clover alone, are the principal hay crops. Timothy is better adapted than clover to this soil, unless the acidity is corrected by applications of lime (3 to 4 tons).

Tomatoes, sweet corn, and other special crops, are grown, but on a small acreage. These crops are usually rather heavily fertilized, but

the yields are somewhat lower than on the Early Wisconsin and Late Wisconsin soils.

**Homer silt loam.**—Developed on the glaciofluvial outwash plains and terraces, this soil is similar in natural drainage conditions to the Crosby, Fincastle, and Whitaker soils but differs in being underlain by loose calcareous gravel and sand. It is the imperfectly drained member of the catena that includes the Fox, Nineveh, Westland, and Abington soils.

A total of 832 acres is mapped in the valleys of the White and Blue Rivers, in the outwash plains adjacent to Sugar Creek, and in other small isolated areas of the outwash plains and terraces, in association with the Westland, Abington, and Fox soils. The soil usually occurs on slightly elevated positions above areas of the Westland. The relief is nearly level, and both internal and external drainage are imperfect. Surface runoff is slow, and under natural drainage conditions the water table is near the surface most of the year. At present most areas are artificially drained to permit cropping. Some, however, need additional drainage. Native vegetation consisted chiefly of maple, sycamore, ash, elm, and oak.

Following is a profile description in cultivated areas:

0 to 7 inches, light brownish-gray friable gritty silt loam, low in organic content Reaction, medium to slightly acid.

7 to 11 inches, brownish-gray to light brownish-gray friable heavy silt loam to silty clay loam, composed of firm but not hard coarse granules. This layer is permeable to moisture movement and plant roots. Reaction, medium acid.

11 to 18 inches, mottled gray, yellow, and rust-brown silty clay loam, containing considerable quantities of rounded glacial gravel. The material breaks into ¼- to ½-inch subangular to angular pieces. It is permeable to moisture movement and plant roots. Reaction, medium acid.

18 to 48 inches, mottled gray, yellow, and rust-brown waxy and gravelly heavy clay loam, containing a large quantity of rounded gravel. The material breaks into angular pieces, plastic when moist, sticky when wet, and hard when dry. This layer is somewhat impermeable to moisture movement and plant roots. The lower part is generally slightly more friable than the upper. Reaction, medium acid in the upper part and generally slightly acid in the lower.

48 inches +, gray and light-yellow loose calcareous stratified gravel and sand.

Variations in the profile characteristics are in texture and thickness of layers and in depth to underlying gravel and sand.

This soil is cropped about the same as the associated soils. The rotation consists chiefly of corn, wheat and hay, with some soybeans, oats, and special crops. Good yields may be maintained and increased if good management is practiced, which involves turning under all available organic matter, applying liberal quantities of commercial fertilizer, and including more hay crops in the rotation.

Corn, an important crop on this soil, yields an average of 30 bushels an acre under present management. It is commonly fertilized with 50 to 150 pounds of commercial fertilizer. Wheat usually follows corn in the rotation, acre yields averaging about 15 bushels. It is a common practice to use 100 to 150 pounds or more of commercial fertilizer for wheat. Some oats are grown and yields average 25 bushels. Hay includes a mixture of alfalfa, clover, and timothy, or alfalfa and clover alone, good stands of which can be obtained by applications of 1 to 2 tons of lime. Some damage is done to these crops from heaving and drowning out, especially on areas having insufficient artificial drainage. Some areas are in permanent bluegrass pasture, but not much attempt has been made toward pasture improvement. A few areas are used for special crops.

**Mahalasville silty clay loam.**—This dark-colored soil, developed on glaciofluvial outwash plains and terraces, is underlain by stratified silt and sand, with some clay and gravel. It is the poorly drained member of the catena that includes the Martinsville and Whitaker soils.

An aggregate of 3,712 acres is mapped in slight depressional areas in old glacial drainageways, and, in a few instances, on rather broad flats. The larger areas are in the eastern part of the county, the smaller ones occurring throughout the regions of outwash plains and terraces. Both external and internal drainage are poor, but most of this soil has been artificially drained sufficiently to permit cropping. Native vegetation consisted of water-tolerant trees, chiefly red maple, elm, black tupelo, and ash, and marsh grasses.

Following is a profile description in cultivated areas:

0 to 7 inches, dark-gray to very dark brownish-gray silty clay loam, relatively high in organic content. Reaction, neutral.

7 to 14 inches, dark-gray silty clay loam to clay loam, with a few light-yellow or rust-brown mottlings in the lower part. The organic content is relatively high, and the material is permeable to moisture movement and plant roots. Reaction, neutral.

14 to 55 inches, mottled gray, yellow, and rust-brown plastic gritty clay loam to silty clay. The material breaks into large angular pieces, plastic when moist, sticky when wet, and hard when dry. The content of rounded pebbles and gravel is small in the upper part and increases with depth. Reaction, neutral.

55 inches +, gray and yellow stratified silt and sand, with small quantities of clay and gravel.

Most of this type has been cleared of forests and at present is largely under cultivation. Except where this soil forms a larger part or all of a field unit, the cropping system is about the same as on the associated Martinsville, Whitaker, and other soils. The common rotation is corn, wheat or oats, and hay. This may be altered to include soybeans and some special crops.

Corn is well adapted to this soil and under present management practices averages about 45 bushels an acre, with yields of 60 bushels or more not uncommon. Corn is generally fertilized about the same as on the associated soils. If this soil makes up most of the field unit, however, or if the phosphate and potash content is high, less fertilizer is usually applied, and corn is occasionally grown for 2 or more consecutive years. When this soil is adequately drained and proper commercial fertilizer high in phosphate and potash is applied, good yields of wheat, oats, and other small grains may be obtained. Some damage is done to fall-sown small grains by freezing and by lodging of the grain. Wheat yields average about 17 bushels an acre and oats about 35. Soybeans are well adapted to this soil, and yields of 20 to 25 bushels are not uncommon.

Hay includes a mixture of clover, alfalfa, timothy, and alsike, or clover or alfalfa grown alone. Clover and alfalfa can be successfully grown on this soil without applying lime, but serious damage to them occasionally results from heaving during winter and early spring. Vegetables, especially tomatoes and sweet corn, are well adapted to the soil, and a considerable acreage is grown. A few areas are in permanent bluegrass pasture or forest.

**Martinsville loam.**—Developed on glaciofluvial outwash plains and terraces, this soil differs from Fox loam in having less coarse-textured material in the surface soil and subsoil and in being underlain by stratified silt and sand, with small quantities of clay and gravel, rather than

by loose gravel and sand. It is the well to excessively drained member of the catena that includes the Whitaker and Mahalasville soils.

A total of 2,496 acres occurs usually in relatively large bodies in association with the Whitaker, Mahalasville, and Abington soils, often in a position intermediate between areas of sweet alluvium and Wisconsin glacial drift upland regions. The relief is nearly level to gently undulating, and internal drainage is good. Surface runoff is not rapid and erosion control not a problem. Native vegetation consisted of a mixed growth of hardwoods, principally white and red oaks, beech, maple, ash, elm, walnut, and hickory.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown friable medium granular loam, relatively low in organic content. In cultivated areas the 2- to 3-inch surface is dark brownish gray and relatively high in organic content. Reaction, slight to medium acid.

7 to 11 inches, light yellowish-brown to yellowish-brown friable coarse granular heavy loam to silty clay loam, breaking into firm but not hard coarse granules. This layer is permeable to moisture movement and plant roots. Reaction, medium acid.

11 to 17 inches, yellowish-brown silty clay loam or clay loam, breaking into ¼- to ½-inch subangular aggregates. The material is permeable to moisture movement and plant roots. Reaction, medium acid.

17 to 45 inches, yellowish-brown to weak reddish-brown gritty clay loam to silty clay loam, breaking into ½- to 1½-inch subangular aggregates. Numerous small rounded pebbles and some gravel are present, especially in the lower part. The lower part is somewhat more friable than the upper. Reaction, medium to slightly acid.

45 inches +, gray and yellow calcareous stratified silt and sand, with small quantities of clay and gravel.

Variations in the profile characteristics are in texture and thickness of layers and in depth to the underlying material. Where areas of this type border those of Fox loam, the subsoil usually contains more grit, pebbles, and gravel than normal.

The principal rotation includes corn, wheat, and hay, with soybeans increasing in importance in the rotation. A considerable part of the soil is used for special crops, especially in the vicinity of canning factories.

Corn usually follows hay in the rotation and yields average 30 bushels an acre under present management practices. It is a common practice to use 50 to 150 pounds or more an acre of commercial fertilizer for corn. Wheat is commonly given applications of 100 to 150 pounds of commercial fertilizer, and an average yield of 20 bushels is obtained. Oats, not so well adapted as wheat to this soil, yield an average of about 25 bushels an acre. Soybeans are usually grown after corn in the rotation, yields averaging about 17 bushels. The common hay crops include a mixture of clover, alfalfa, timothy, and alsike, or clover or alfalfa grown alone. It is necessary to apply lime (1 to 2 tons) for successfully growing alfalfa. Because of the better moisture relation, this soil is probably better adapted than Fox loam to growing clover. A few areas are in permanent bluegrass pasture and forest.

**Martinsville silt loam.**—Developed on glaciofluvial outwash plains and terraces, this well to excessively drained soil is underlain by stratified calcareous silt and sand, with some clay and gravel. It is similar to Martinsville loam in profile characteristics, except for the silt loam surface soil; the heavier textured subsoil, which usually contains less pebbles and gravel; and the usually slightly greater depth to the underlying material.

A total of 1,408 acres is mapped in relatively large bodies, the larger ones in the vicinity of Smith Valley and in the eastern part of the county. The relief is nearly level to gently undulating. Management practices and rotation systems are similar to those on Martinsville loam, and, owing to the better moisture relations, yields of most crops are slightly higher.

**Miami loam.**—Developed on Late Wisconsin glacial drift in association with Bellefontaine loam and Princeton fine sandy loam, this well-drained soil differs from Miami silt loam in the rather high content of fine sand in the surface soil and upper subsoil. The fine sand represents material deposited by wind action. The organic content of the surface soil is relatively low, especially in cultivated areas.

A total of 1,472 acres is mapped on the morainic belt lying between Greenwood and Rocklane, southwest of Smith Valley, and in the vicinity of Franklin. It occupies slopes of 3 to 15 percent, and both surface and internal drainage are good. Owing to the somewhat more porous nature of the surface soil and upper subsoil, erosion control is not so much of a problem as on Miami silt loam. Moisture supplies, however, may become somewhat deficient during summer.

The original vegetation consisted chiefly of sugar maple, beech, hickory, white oak, walnut, elm, and ash. At present most of this soil is under cultivation and but little woodland remains.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown friable granular loam, relatively low in organic matter. Reaction, slight to medium acid.

7 to 11 inches, light yellowish-brown to yellowish-brown friable granular heavy loam to light silt loam, somewhat lower in organic content than the above layer. Reaction, medium acid.

11 to 32 inches, yellowish-brown to brownish-yellow silty clay loam, breaking in to ¼- to ¾-inch subangular or nuciform aggregates in the upper part and ½- to 1½-inch subangular aggregates in the lower. These aggregates become hard when dry but may be easily broken down into coarse granules when moist. Reaction, medium acid.

32 to 38 inches, yellowish-brown to dark yellowish-brown somewhat friable silty clay loam, breaking into irregular-sized subangular aggregates that are easily broken down when moist but become hard when dry. Reaction, slightly acid to neutral.

38 inches +, gray and yellow somewhat compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments. This represents the parent soil material.

Variations in the profile are in the content of sand in the surface soil and subsoil and in depth to calcareous till. In a few small areas immediately adjacent to Princeton fine sandy loam the surface layer is a fine sandy loam, and the depth to calcareous till is greater than normal.

Most of this type has been cleared and is under cultivation to the general farm crops of the region, principally corn, wheat, and hay. Crop yields are about the same as on Miami silt loam, but alfalfa is more extensively grown.

**Miami silt loam.**—This is the most extensive well-drained soil in the county, occurring in association with the Bellefontaine, Crosby, Bethel, Brookston, and Clyde soils in the region of Late Wisconsin glacial drift. It occupies the sloping areas along drainageways, especially in the western part, and morainic knolls in the interstream areas, the largest belt extending eastward from Greenwood through Rocklane. These knolls range from a few feet to over 30 feet above the surrounding areas.

The soil association map (fig. 3) shows the location and extent of the largest areas of this soil. An aggregate area of 29,696 acres, or 14.4 percent of the county, is mapped. The soil occurs on slopes of 3 to 15 percent, and surface drainage is good to excessive and internal drainage good. Erosion control becomes a problem on steep sloping areas, especially where a protective cover crop is absent during winter.

The native vegetation consisted chiefly of sugar maple, beech, ash, elm, walnut, hickory, and white oak. Only a small part of this soil is at present in woodland.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown to yellowish-brown friable granular silt loam, relatively low in organic matter. Reaction, slight to medium acid.

7 to 10 inches, yellowish-brown to brownish-yellow friable coarse granular heavy silt loam, lower in organic content than the above layer. Reaction, medium acid.

10 to 30 inches, yellowish-brown to brownish-yellow silty clay loam breaking into ¼- to ¾-inch subangular or nuciform aggregates in the upper part and ½- to 1½-inch subangular aggregates in the lower, hard when dry but easily broken down into coarse granules when moist. Reaction, medium acid.

30 to 36 inches, yellowish-brown to dark yellowish-brown silty clay loam, slightly more friable than the above layer but generally neutral to slightly acid.

36 inches +, gray and yellow compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments.

With the exception of the texture of surface layer this soil varies in texture, structure, and thickness of the various layers. A few areas contain abnormal quantities of sand and gravel. In the western part of the county, principally west of Kinder, bedrock of sandstone, siltstone, and shale lies within a few feet of the surface in a few areas.

The greater part of this soil has been cleared for cultivation. It is estimated that only about 5 percent is in woodland, about 8 percent in permanent blue grass pasture, and the rest under cultivation. It is extensively used as farm sites, especially on the morainic knolls which occur on the divides.

A 3-year rotation of corn, wheat or oats, and legumes is the principal one in use on this soil. More corn than any other crop is grown, and yields average about 35 bushels an acre. Higher yields are frequently obtained, especially when a large quantity of manure and sufficient commercial fertilizer is used. Due to the good natural drainage and aeration, this soil is well suited to growing corn, although the relatively low content of nitrogen and somewhat inadequate supply of moisture during summer limit the yield. Clean cultivation on the more rolling areas encourages erosion, and the lack of a vegetative cover during winter makes corn an undesirable crop unless followed by fall-seeded small grains, as wheat and rye.

Wheat normally follows corn in the rotation but may be seeded after oats, soybeans, or special crops. It is well suited to this soil, as it requires a well-drained soil for best results. This crop aids in retarding erosion by furnishing a protective cover during winter, especially on the more sloping areas. Wheat is generally fertilized, the quantity and quality of fertilizer varying somewhat in different parts of the county. The quantity generally averages about 125 pounds an acre. Yields of 15 to 20 bushels are obtained, but with adequate fertilizer and good seasonal growing conditions they may be as high as 25 to 30 bushels. As this soil dries more quickly in spring and permits early seasoning, oats are grown on it to a slightly greater extent than on the associated

poorly drained soils. Oats are usually seeded in the corn stubble but may occasionally be seeded after vegetables and where legume crops have failed.

Hay generally consists of a mixture of red clover, alsike, alfalfa, timothy, and occasionally redtop and bromegrass, or alfalfa and clover alone. It is essential that sufficient lime be applied to the soil for successfully growing clover and alfalfa, which are usually seeded in wheat or rye or with oats in spring. An occasional area is seeded in late summer or early fall. Soybeans are becoming an important crop and in recent years are grown largely for seed. They are sown late in May or in June and the average yield is about 17 bushels an acre. Some areas are planted to tomatoes, sweet corn, and pumpkins, but the total acreage is not large.

**Miami silt loam, eroded phase.**—This phase, occurring on slopes of more than 10 percent, has lost more than 50 percent of the surface soil and a part of the subsoil by accelerated erosion. The yellowish-brown subsoil is exposed in numerous places, reducing tilth conditions and lowering the fertility of the soil. An aggregate area of 4,992 acres is mapped. Most of the general farm crops are grown on this phase, but yields are much lower than those obtained on the uneroded normal soil. It is essential that improved management practices be used on this phase, which involve plowing under organic matter, applying the proper quantity and quality of commercial fertilizers and lime, and using erosion control measures to maintain and increase fertility. Although many of the more seriously eroded fields are at present in permanent bluegrass pasture, stands are poor and little effort is made to improve them.

**Miami silt loam, gullied phase.**—This phase includes areas where numerous gullies have developed, most of which are several feet deep and cannot be crossed by tillage implements. These areas, in general, are on slopes of more than 10 percent. The intergully areas are usually severely sheet eroded. A total of 448 acres is mapped, mostly along large streams with a few areas on the steeper parts of the moraines of the interstream areas. These areas, formerly cultivated, are now in low-grade pasture or are idle. This phase is not suited for agricultural purposes but can be reforested.

**Miami silt loam, sloping phase.**—The profile characteristics of this phase are similar to those of the normal type, except that the layers are thinner. A total area of 4,224 acres occurs on slopes of 15 to 25 percent or more. About 75 percent of it is in forest or permanent bluegrass pasture, and about 25 percent is cultivated to about the same crops as those grown on the normal soil. The yields, however, are somewhat lower, owing to the rapid surface runoff and consequent limited moisture supply. Under proper management, which involves fertilizing, liming, and erosion control, good stands of pasture can be maintained. Maintenance of fertility is very important. This can best be accomplished by plowing under sufficient organic matter and properly controlling erosion. Under improper management erosion becomes a serious factor.

Included with this phase are small areas on the steeper slopes where bedrock of sandstone, siltstone, and shale occur at a shallow depth. On the very steep slopes a few areas of bedrock outcrops also are included.

**Muskingum stony silt loam.**—This soil occurs on slopes of more than 12 percent in the region of Borden sandstone, siltstone, and shale, in association with the Wellston and Zanesville soils. Numerous rock fragments occur on the surface and throughout the profile.

A total of 896 acres is mapped in the extreme southern part of the county west of Peoga. Owing to the sloping relief, external drainage is excessive. Internal drainage is good to excessive. The native vegetation consisted chiefly of oak and hickory.

Following is a profile description in undisturbed wooded areas:

0 to 2 inches, light yellowish-brown to grayish-yellow silt loam, relatively high in organic matter. Numerous various-sized sandstone, siltstone, and shale fragments occur on the surface and throughout this layer. Reaction, strongly to slightly acid.

2 to 20 inches, light brownish-yellow to light yellowish-brown friable silt loam, containing numerous rock fragments. Reaction, strongly acid.

20 inches +, bedrock of sandstone, siltstone, and shale.

Variations in the profile characteristics are in texture of subsoil and depth to bedrock. In some areas there is a slight profile development in the subsoil. Here the texture is heavy silt loam to silty clay loam, breaking into small subangular aggregates.

Practically all this soil is in woodland; only a few small areas are cropped. Cultivation is not advisable, because of the susceptibility to erosion and the presence of numerous rock fragments on the surface and throughout the soil.

**Nineveh loam.**—Developed on the glaciofluvial outwash plains and terraces in association with the Westland, Abington, Fox, and Homer soils, this well to excessively drained soil differs from Fox loam in having a dark brownish-gray to dark-brown surface layer about 10 inches thick, less acid surface soil and subsoil, and shallower depth to loose calcareous gravel and sand.

An aggregate area of 1,216 is mapped, the largest areas in sections 10 to 15 of Needham Township, immediately east of Edinburg, and about 1½ miles west of Edinburg. Small isolated areas occur in the stream and river valleys of the Wisconsin drift regions. The areas in sections 10 and 15 of Needham Township adjacent to Shelby County, are more than a square mile in extent, with only a few very small areas of Westland silty clay loam associated. Native vegetation consisted of black and red oaks, maple, walnut, ash, and hackberry.

Following is a profile description in cultivated areas:

0 to 7 inches, dark brownish-gray to dark-brown friable gritty loam, containing considerably more organic matter than the surface soil of Fox loam. Reaction, slightly acid to neutral.

7 to 10 inches, dark-brown to dark brownish-gray friable coarse granular heavy loam to silty clay loam, containing much small rounded glacial gravel. Reaction, slightly acid to neutral.

10 to 20 inches, yellowish-brown sandy clay loam, breaking into small somewhat angular aggregates, easily crushed when moist and hard when dry. Reaction, slightly acid to neutral.

20 to 30 inches, yellowish-brown to weak reddish-brown waxy and gravelly clay loam, containing numerous rounded glacial gravel. The material breaks into angular pieces, plastic when moist, sticky when wet, and hard when dry. Reaction, slightly acid to neutral.

30 to 34 inches, dark-brown to dark brownish-gray waxy and gravelly heavy clay loam, breaking into large angular pieces. There is an abrupt change from the above layer to this material and from this to the underlying material. Tongues or lenses of this layer extend into the underlying material. Reaction, slightly acid to neutral.

34 inches +, gray and light-yellow loose calcareous stratified gravel and sand, containing a high percentage of limestone.

Variations in the profile characteristics are in texture and thickness of the layers and depth to the underlying gravel and sand. In a few areas abnormally large quantities of small rounded gravel are on the surface and throughout the soil.

Corn, soybeans, and legumes are more extensively grown on this than on the Fox soils because of the higher organic content of the surface soil and the slightly acid to neutral reaction of the surface and subsoil layers. The rotation system in common use includes corn, wheat or oats, and hay. Corn usually follows hay in the rotation and yields average 35 bushels an acre. It is a common practice to use 50 to 150 pounds of commercial fertilizer for corn, the fertilizer containing less nitrogen than that used for corn on the Fox soils. Where field units are composed almost entirely of this soil, corn is occasionally grown for 2 or more consecutive years. Most farmers apply 100 to 150 pounds of commercial fertilizer for wheat, and average yields of about 20 bushels are obtained. Oats are probably somewhat better adapted to this soil than to the Fox soils, but because of the low moisture conditions during summer the yields are relatively low.

Hay includes a mixture of alfalfa, clover, and timothy, or alfalfa and clover grown alone. Good stands of alfalfa and clover can be obtained without applications of lime. Alfalfa, however, is better suited than clover to this soil.

A few areas are used for tomatoes, sweet corn, canning peas, and other vegetables, good yields being obtained when the crops are properly fertilized.

**Philo silt loam.**—This is a moderately well-drained alluvial soil of the flood plains in the regions of Illinoian glacial drift and Borden sandstone, siltstone, and shale. It occupies a total of 128 acres in the broader bottoms of the streams and drainageways in the southwestern part of the county in association with Pope silt loam, often occurring in the lower part of the bottoms between areas of Pope silt loam and the sweet alluvial soils. The upper part of the profile is well drained, but the lower part has somewhat restricted drainage. Native vegetation consisted chiefly of oak, hickory, elm, ash, and beech.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown to light brownish-yellow friable medium-granular silt loam, relatively low in organic matter. Reaction, strong to very strongly acid.

7 to 18 inches, light brownish-yellow medium-granular heavy silt loam to silty clay loam, in which thin depositional layers, representing old stages of deposition, can be recognized. Reaction, strong to very strongly acid.

18 inches +, mottled gray, yellow, and rust-brown silt loam to plastic silty clay loam. The texture is variable and old depositional layers can be easily distinguished. Reaction, strong to very strongly acid.

Owing to its occurrence on somewhat wider and larger areas, more of this soil than of Pope silt loam is under cultivation. Corn, wheat, soybeans, and hay are the principal crops. Corn yields average 40 bushels an acre, wheat about 15 bushels, and soybeans about 18 bushels, with the use of very little commercial fertilizer. Hay includes a mixture of timothy, clover, and some lespedeza. It is essential that this soil be given sufficient applications of lime (3 or 4 tons an acre) for success with clover. Some areas are in permanent bluegrass pasture. Good stands

of pasture can be maintained after liming and by the use of the proper fertilizer.

**Pope silt loam.**—This well-drained alluvial soil of the flood plains in the regions of Illinoian drift and Borden sandstone, siltstone, and shale is adjacent to the streams and drainageways in the southwestern part of the county, associated with Philo silt loam. The areas are generally rather long and narrow, and the greater part of the 448 acres mapped remains in forest. Drainage is good, but practically all areas are subject to overflow. Native vegetation consisted chiefly of oak, hickory, beech, maple, ash, and elm.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown to yellowish-brown friable medium-granular silt loam, relatively low in organic matter. Reaction, strongly to very strongly acid.

7 to 20 inches, yellowish-brown to brownish-yellow friable coarse granular heavy silt loam to silty clay loam, having a platy structure. Thin depositional layers, representing old stages of deposition, can be recognized in the material, and fragments of tree branches, leaves, and other organic matter are generally present. Reaction, strongly to very strongly acid.

20 inches +, yellowish-brown to brownish-yellow heavy silt loam to plastic silty clay loam, somewhat variable in texture and composition, with old depositional layers easily distinguished. Reaction, strongly to very strongly acid.

Variations in the profile characteristics are in texture and thickness of layers. Considerable colluvial material from the surrounding uplands is on areas that occur in the upper part of the drainageways.

Owing to its occurrence in long and very narrow areas, usually broken by numerous drainageways from the steeply sloping upland areas, this soil is not well suited to cultivation, and field units generally are extremely small. Some corn, wheat, and soybeans are grown, and a few areas are in permanent bluegrass pasture. Very little commercial fertilizer is used for corn, which yields an average of 40 bushels an acre. Wheat yields about 15 bushels. Hay includes a mixture of timothy, clover, and some lespedeza.

**Princeton fine sandy loam.**—The only soil developed on wind-blown material, this type occurs in small isolated areas along the bluffs of the valley of the White River southwest and northeast of Smith Valley. A total of 192 acres is mapped, usually in association with the Bellefontaine and Miami soils, especially Miami loam, on upland areas. The relief ranges from nearly level to rolling and is often dunelike. Owing to the porous nature of the material, there is little surface runoff, and internal drainage is good to excessive. The native vegetation consisted chiefly of oak.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown fine sandy loam, relatively low in organic matter Reaction, medium to slightly acid.

7 to 12 inches, light yellowish-brown to yellowish-brown fine sandy loam. Reaction, medium acid.

12 to 36 inches, yellowish-brown friable sandy clay loam to clay loam. Reaction, medium acid.

36 to 55 inches, yellowish-brown to brownish-yellow loose fine sand to sandy loam. Reaction, medium to slightly acid.

55 inches +, gray and yellow loose calcareous fine sand to sand.

The variations in the profile characteristics are in texture and thickness of the layers and thickness of the sandy wind-blown deposits. In some areas where this soil grades into the associated glacial till soils, the total

thickness is less than normal and unassorted glacial till occurs at a depth of 3 or 4 feet.

Where this soil occurs in small areas, closely associated with the Miami and other soils, it is cropped about the same as the associated soils. The rotation generally includes corn, wheat, and hay. Corn yields average 20 bushels an acre and wheat 10 bushels. Oats are not adapted to this soil and yields are low. Organic matter may be increased and moisture conserved by plowing under all available plant residue.

Alfalfa is probably better suited to this soil than clover and timothy, although it is necessary to correct the acidity before good stands can be obtained. Special crops—watermelons, cantaloups, sweetpotatoes, and early tomatoes—are well suited to the soil and are grown on a few of the larger areas.

**Ross silty clay loam.**—This well-drained dark-colored soil on alluvium washed from regions of Wisconsin glacial drift and glaciofluvial outwash plains and terraces differs from the Genesee soils principally in the darker color and higher organic content of the surface and upper subsoil layer. A total of 768 acres is mapped. It occurs on the flood plains of the White and Blue Rivers and Sugar Creek in association with the Genesee and Eel soils. Often lying adjacent to the sloping areas of the Fox and Miami soils, the darker color of the surface and upper subsoil layers is due, in part, to the high content of lime in the wash from those soils. It frequently occupies a slightly elevated position above the Genesee soils and is not subject to so frequent overflow as the associated alluvial soils. Native vegetation consists chiefly of sycamore, elm, and ash.

Following is a profile description in cultivated areas:

0 to 7 inches, dark yellowish-brown or dark-brown silty clay loam, relatively high in organic matter. Reaction, neutral to slightly acid.

7 to 20 inches, dark-brown or dark yellowish-brown heavy silty clay loam or silty clay, breaking into angular irregular-sized pieces, tough when moist and hard when dry. Reaction, neutral to slightly acid.

20 inches +, brown or yellowish-brown tough silty clay loam to silty clay. There is a gradual change in color from the above material to this layer, and below a depth of 36 inches the material is somewhat more friable. Layers of sand and gravel occur in the deeper substratum. Reaction, neutral to alkaline.

Variations in the profile characteristics are in color, texture, and thickness of the layers. Areas bordering the Genesee soils have lighter colored and somewhat lighter textured surface soils than normal.

Practically all this soil is cleared and cultivated, less than 5 percent remaining in forest. Owing to its close association with the Genesee soils, the rotation system is about the same as on those soils. Corn and wheat are the principal crops, but alfalfa and soybeans are also important in the rotation. Corn usually receives acre applications of 50 to 150 pounds of commercial fertilizer and yields average about 45 bushels an acre, although considerably higher yields are not uncommon, especially when properly fertilized. Clover and alfalfa can be successfully grown without additional lime, but some injury results from heaving and flooding.

**Russell silt loam.**—Developed on Early Wisconsin glacial drift, often in close association with the Fincastle, Delmar, Bellefontaine, and Brookston soils, this well-drained soil differs from Miami silt loam in the more silty nature of the surface soil and upper subsoil, the small quantities of grit and fine sand in the upper subsoil, the somewhat more acid surface soil and subsoil, and the greater depth to calcareous till.

It is a major soil type in region E on the soil association map (fig 3). The parent material is unconsolidated silt, clay, sand, and rock fragments, deposited by the Early Wisconsin glacier. The composition of this material is very ununiform and may vary greatly within a short distance; consequently, there are local variations in the profile both in color and texture of the various layers. On slopes of less than 3 percent the subsoil is usually more friable than normal and the underlying material more porous.

The aggregate area is 5,376 acres, the larger areas occurring adjacent to the drainageways and on the morainic knolls in the interstream areas. It occurs on a rather wide range of surface relief, from nearly level to more than 15 percent, but is typically and more extensively developed on slopes of 3 to 7 percent. External drainage is good to excessive and, except in the lower subsoil in a few areas, internal drainage is good. The native vegetation consisted of a dense growth of deciduous trees, chiefly white oak, hickory, ash, elm, maple, and poplar, with some sycamore and beech.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown to yellowish-brown grit-free friable granular silt loam, relatively low in organic content. Reaction, medium acid.

7 to 10 inches, light yellowish-brown to brownish-yellow friable heavy silt loam, usually free of grit and pebbles and permeable to roots and moisture. Reaction, medium to strongly acid.

10 to 18 inches, brownish-yellow to yellowish-brown silty clay loam, breaking into ¼- to ½-inch subangular aggregates, hard when dry but easily crushed into coarse granules when wet. Reaction, strongly to medium acid.

18 to 36 inches, brownish-yellow to yellowish-brown compact silty clay loam, breaking into ½- to 1½-inch subangular aggregates. A thin coating of gray colloidal material occurs on many of the cleavage faces, giving a somewhat mottled appearance in places, but the gray color disappears when the material is crushed. Reaction, strongly to medium acid.

36 to 45 inches, brownish-yellow silty clay loam, containing much grit and numerable small rock fragments. The material is less compact and more friable than the above layer, breaking into irregular-sized subangular chunks. Reaction, medium to slightly acid.

45 inches +, gray and yellow compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics are in the texture and thickness of the layers.

Crop rotations and management practices are similar to those on Miami silt loam. The principal rotation is a 3-year one of corn, wheat or oats, and hay. This may be varied to include rye, soybeans, and special field crops and vegetables.

Corn generally follows hay in the rotation. The use of commercial fertilizer on this soil is increasing, and it is a common practice to manure areas to be planted to corn. The average yield of 35 bushels an acre under the prevailing management practices becomes substantially higher under good practices, which involve using sufficient commercial fertilizer of the proper analyses, turning under manure and crop residue, and using a rotation system that includes clover, alfalfa, and other hay crops, and less clean-cultivated crops. Wheat generally follows corn in the rotation, and in some instances oats or soybeans. Wheat is commonly fertilized with 125 to 150 pounds of 2-12-6 or 2-12-12 fertilizer an acre, and some wheat is given a top dressing of manure. Yields of 15 to 25 bushels under the prevailing management can be increased by using more commercial fertilizer and better rotation systems. Oats are sown in spring in corn stubble or follow wheat or vegetables, and very little commercial ferti-

lizer is used. Yields, usually limited by weather conditions during the growing season, range from 25 to 45 bushels an acre.

Hay includes clover, alfalfa, timothy, and alsike, with small areas of bromegrass, generally grown as a mixture. Some alfalfa and clover, however, are grown alone, but to obtain good stands sufficient applications of lime (1 to 3 tons an acre) are necessary. On areas that have not been properly managed, it is also important to apply phosphate and potash fertilizers to assure good stands of hay crops. This is generally better accomplished by applying large quantities of fertilizer at the time of seeding small grains, which usually precede hay.

Soybeans are increasing in importance on this soil. They usually follow either small grains or corn in the rotation but sometimes follow vegetable crops, yielding 15 to 25 bushels an acre, but yields of 30 bushels or more are obtained under good management and favorable weather conditions. A small acreage is used for sweet corn, tomatoes, and field peas.

Included with this type on the map are a few areas that have loam surface soils. These areas, probably representing a thin smear of windblown sand, are generally associated with Princeton fine sandy loam. Also included are small areas in the western part of the county where the mantle of glacial till is only a few feet thick over bedrock of sandstone, siltstone, and shale.

**Russell silt loam, eroded phase.**—This phase occurs on slopes of 10 percent or more. A large part of it has lost 50 percent or more of the surface soil and a part of the subsoil by accelerated erosion, the heavier textured yellowish-brown subsoil either being exposed or forming part of the surface 6 inches. This lowers tilth conditions and reduces the organic and plant-nutrient content of the soil, therefore crop yields are somewhat lower than on the typical soil. A total area of 1,728 acres of this phase is mapped.

About the same crops are grown as on the normal soil, with corn, wheat or oats, and hay the principal crops. To maintain and increase fertility and prevent or arrest further erosion it is essential that good management be practiced, which involves turning under adequate quantities of organic matter, applying adequate quantities of commercial fertilizer, and using a rotation system that includes more clover and alfalfa and not too many clean-cultivated crops. Good stands of bluegrass can be obtained by using sufficient lime and commercial fertilizer.

**Russell silt loam, sloping phase.**—This phase has essentially the same profile characteristics as the typical soil, except that the layers are thinner. The glacial till is only a few feet thick over bedrock of sandstone, siltstone, and shale. The total area is 2,944 acres, the larger areas occurring in the western part of the county, principally adjacent to streams. The relief ranges from 15 to 30 percent or more.

Only a few areas are at present under cultivation, as this phase is largely in forest or pasture. Because of restricted moisture conditions, crop yields are somewhat lower than on the typical soil. When sufficient lime and fertilizer are applied goods stands of bluegrass pasture can be maintained, but at present there is little attempt toward pasture improvement. Erosion control is a major problem, and where cultivation has taken place over an extended period, rather severe accelerated erosion has developed.

Included with this phase on the map are a few narrow areas on the steeper slopes with bedrock outcrops.

**Wellston silt loam.**—Developed on Borden sandstone, siltstone, and shale, this well-drained soil differs from Zanesville silt loam in the occurrence of bedrock at a depth of about 30 to 36 inches. A total of 128 acres occurs on the ridge tops of the Norman Upland physiographic region in the extreme southwestern part of the county west of Peoga. It is associated with Zanesville silt loam on the broader ridge tops and is often the only soil mapped on the narrow ridge tops. The steeper slopes adjacent to this soil are usually Muskingum stony silt loam. The relief ranges from 3 to 15 percent. Surface drainage is good on the milder slopes and excessive on the steeper ones, and internal drainage is good to somewhat excessive. The native vegetation consisted chiefly of red, white, and black oak and hickory.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown friable medium granular silt loam, low in organic content. The surface 2 or 3 inches is darker in color in wooded areas. Reaction, strongly acid.

7 to 12 inches, light yellowish-brown to brownish-yellow coarse-granular heavy silt loam to silty clay loam, permeable to moisture movement and to plant roots Reaction, strong to very strongly acid.

12 to 30 inches, brownish-yellow to yellowish-brown silty clay loam, breaking into subangular aggregates ¼ to ½ inch in diameter in the upper part and ½ to 1½ inches in the lower. The lower part contains numerous small partly weathered fragments of sandstone, siltstone, and shale.

30 inches +, bedrock of sandstone, siltstone, and shale.

Variations in the profile characteristics are in texture and thickness of the layers and depth to bedrock. Where bedrock occurs at depths of more than 32 inches the lower subsoil is slightly mottled with gray and light yellow.

Only a small part of this soil is at present under cultivation, the principal crops being corn, wheat, and hay. Corn yields average about 15 bushels an acre and wheat 7. Hay generally includes a mixture of timothy and clover, with some redtop and lespedeza. Timothy is probably better adapted than clover to this soil. To grow clover successfully it is necessary to apply sufficient lime (3 to 4 tons an acre). A large part of this soil has been abandoned and now supports a growth of poverty oatgrass, broomsedge, briers, and sassafras.

**Westland silty clay loam.**—This dark-colored soil, developed on glaciofluvial outwash plains and terraces, is underlain by stratified calcareous gravel and sand. It is the poorly drained member of the soil catena that includes also the Fox, Nineveh, Homer, and Abington soils. A total of 4,032 acres occurs in slight depressional areas in old abandoned glacial drainageways and in rather broad flats. The larger areas are on the outwash plains and terraces in the eastern part of the county, usually associated with the Fox, Homer, and Abington soils. Both internal and external drainage conditions are poor, but the greater part of the soil has been artificially drained for cropping. Native vegetation consists of water-tolerant trees, chiefly red maple, elm, ash, and black tupelo and marsh grasses.

Following is a profile description in cultivated areas:

0 to 7 inches, dark-gray to very dark brownish-gray silty clay loam, relatively high in organic content Reaction, neutral.

7 to 14 inches, dark-gray to dark brownish-gray silty clay loam to clay loam, with a few light-yellow or rust-brown mottlings in the lower part. The organic

content is relatively high. Numerous glacial gravel are present. The material is permeable to moisture movement and to plant roots. Reaction, neutral.

14 to 50 inches, mottled gray, yellow, and rust-brown waxy and gravelly clay loam, breaking into large angular pieces, plastic when moist and hard when dry. Rounded pebbles and gravel are rather numerous in the upper part, increasing with depth. Reaction, neutral.

50 inches +, gray and yellow calcareous stratified gravel and sand

Variations in the profile characteristics are in organic content of the surface and subsurface layers, texture and thickness of the various layers, and depth to calcareous gravel and sand.

Practically all areas have been cleared of trees, and a large part at present is under cultivation. Except where this soil forms the greater part or all of the field unit, the cropping system is about the same as on the associated Fox, Homer, and Abington soils. The rotation system includes corn, wheat or oats, and hay, altered to include soybeans, and some special crops. Corn is well adapted and under present management practices yields average 45 bushels an acre, but not uncommonly 60 bushels or more are obtained. This soil is generally fertilized about the same as the associated soils, except where it covers a larger part of a field unit, in which instance less fertilizer is applied, or fertilizer high in phosphate and postash is used, and corn is occasionally grown for 2 or more consecutive years. Good yields of wheat, oats, and other small grains may be obtained when adequate drainage is provided and the proper commercial fertilizer high in phosphate and potash is used. Wheat yields average about 17 bushels an acre and oats 35. Soybeans are well adapted, yielding 18 to 25 bushels. Some damage results to fall-sown grains from freezing out and to small grains, including oats, from lodging.

Hay includes a mixture of clover, alfalfa, timothy, and alsike, or clover or alfalfa grown alone. It is not necessary to apply lime to grow clover and alfalfa successfully, but serious damage occasionally results from heaving during winter and early spring. The soil is well adapted to vegetables, and a considerable quantity of tomatoes and sweet corn are grown. Some areas are in permanent bluegrass pasture and a few small ones are in forest or woodland pasture.

**Whitaker loam.**—Developed on glaciofluvial outwash plains and terraces, this imperfectly drained light-colored soil is underlain by stratified silt and sand, with some clay and gravel. With the exception of the loam surface soil and usually lighter textured subsoil, it is similar to Whitaker silt loam in profile characteristics. A total of 384 acres is mapped, principally in the eastern and northwestern parts of the county. The cropping system and management practices are similar to those on Whitaker silt loam, but yields are slightly lower because of the slightly less favorable moisture relations.

**Whitaker silt loam.**—Developed on stratified calcareous silt and sand, with some clay and gravel, this light-colored soil is the imperfectly drained member of the catena that includes also the Martinsville and Mahalasville soils. It differs from Homer silt loam in having less sand and gravel in the subsoil and in being underlain predominantly by silt and sand rather than by gravel and sand. An aggregate of 640 acres is mapped, principally in association with the Martinsville and Mahalasville soils, the larger areas in the eastern and northwestern parts of the county. The relief is nearly level, and surface drainage is slow and internal drainage imperfect. The greater part of the soil has been arti-

ficially drained for cropping. The native vegetation consisted chiefly of oak, maple, beech, elm, and ash.

Following is a profile description in cultivated areas:

0 to 7 inches, brownish-gray or light brownish-gray friable medium-granular silt loam, relatively low in organic content; in cultivated areas the surface 2 to 3 inches dark brownish gray and relatively high in organic content. Reaction, slight to medium acid.

7 to 10 inches, brownish-gray to light brownish-gray friable coarse granular heavy silt loam, containing a small quantity of grit and rounded pebbles and permeable to moisture movement and to plant roots. Reaction, medium acid.

10 to 16 inches, mottled gray, yellow, and rust-brown silty clay loam, breaking into ¼- to ½-inch subangular aggregates, easily broken down into coarse granules; permeable to moisture movement and to plant roots. Reaction, medium acid.

16 to 36 inches, mottled gray, yellow, and rust-brown heavy silty clay loam, breaking into ½- to 1½-inch subangular particles; somewhat compact in place, slightly plastic when moist and hard when dry. Reaction, medium acid.

36 to 45 inches, mottled gray, yellow, and rust-brown silty clay loam, somewhat less compact and more friable than the above layer, breaking into pieces of irregular size and shape and containing considerable quantities of rounded sand and gravel. Reaction, medium to slightly acid.

45 inches +, gray and yellow stratified calcareous silt and sand, with small quantities of clay and gravel.

With the exception of the texture of the surface layer, variations in the profile characteristics are in texture and thickness of the various layers and in depth to underlying stratified material.

The rotation system and management practices are similar to those on the associated soils, but a larger proportion of manure and other organic material is generally applied than on the dark-colored soils. The common rotation includes corn, wheat or oats, and hay. Corn yields average 30 bushels an acre and may be increased materially under better management practices. Wheat yields average 15 bushels. It is a common practice to use applications of 100 to 150 pounds of commercial fertilizer under both corn and wheat. Hay includes a mixture of clover, alfalfa, timothy, and alsike, or clover or alfalfa grown alone. It is necessary to apply lime (1 to 2 tons an acre) to this soil for success with clover and alfalfa. Soybeans are increasing in importance in the rotation and yields average about 15 bushels an acre. Tomatoes, sweet corn, and other crops are grown on a few areas.

**Zanesville silt loam.**—This soil, well-drained and developed on sandstone, siltstone, and shale of the Borden formation, is very inextensive, occupying only 64 acres on the broader ridge tops of the Norman Upland physiographic region in the extreme southwestern part of the county west of Peoga. It is associated with Wellston silt loam on the ridge tops, and the adjacent slopes are Muskingum stony silt loam. The relief is gently undulating to sloping—2 to about 12 percent. Surface drainage is good on the milder slopes, and runoff excessive on the steeper slopes. Internal drainage is usually good, although the presence of a compact siltpan layer at a depth of about 30 inches restricts moisture movement in the lower subsoil. Native vegetation consisted chiefly of white, red, and black oaks, with smaller numbers of hickory, tuliptree (yellow-poplar), and other associated species.

Following is a profile description in cultivated areas:

0 to 7 inches, light yellowish-brown to brownish-yellow friable medium-granular silt loam, relatively low in organic content; the surface 2 or 3 inches in undisturbed wooded areas is dark brownish gray. Reaction, strongly acid.

7 to 12 inches, light yellowish-brown to yellowish-brown smooth coarse granular heavy silt loam to silty clay loam, permeable to moisture movement and to plant roots. Reaction, strongly acid.

12 to 30 inches, yellowish-brown to brownish-yellow silty clay loam, breaking into subangular aggregates ¼- to ½-inch in diameter in the upper part and ½- to 1½-inches in the lower; permeable to moisture movement and to plant roots. Reaction, strongly acid.

30 to 36 inches, brownish-yellow compact silty clay loam, breaking into medium-sized subangular aggregates or into vertical columns; impervious to moisture movement and to plant roots. Reaction, strongly acid

36 to 60 inches, brownish-yellow somewhat friable silty clay loam, with streaks, blotches, and mottlings of gray and light yellow, the lower part containing numerous partly weathered rock fragments of sandstone, siltstone, and shale. Reaction, strongly acid.

60 inches +, bedrock of sandstone, siltstone, and shale.

About 50 percent of this type has been cleared of forest and cultivated. Owing to lack of proper management the fertility level is so low that a large part of the soil has been abandoned and now supports a growth of broomsedge, poverty oatgrass, briers, and sassafras

The common rotation includes corn, wheat, and hay with occasionally soybeans and other field crops. Corn yields average 20 bushels an acre under present management but this can be increased under good practices. Wheat yields average 10 bushels. Very little oats are grown as they are not well adapted. Hay generally consists of a mixture of timothy, clover, and redtop, with some lespedeza, although timothy or clover alone may be grown. To grow clover successfully, applications of lime (3 to 4 tons an acre) are necessary.

**Zanesville silt loam, eroded phase.**—This phase occurs on slopes of 2 to 12 percent and has lost a large part of the surface soil and part of the subsoil by accelerated erosion. On a few areas where severe gully erosion occurs, gullies are numerous and often extend to the underlying bedrock.

A total of 64 acres is mapped in the region of Borden sandstone, siltstone, and shale in the extreme southwestern part of the county in association with Zanesville and Wellston silt loams on the ridges and Muskingum stony silt loam on the associated steeper slopes.

Following is a profile description in cultivated areas:

0 to 7 inches, yellowish-brown to brownish-yellow heavy silt loam to silty clay loam, very low in organic content, representing a mixture of the normal surface and upper subsoil layers and in many places composed largely of the upper subsoil material Reaction, strongly acid.

7 to 12 inches, brownish-yellow silty clay loam composed of coarse granules to small subangular aggregates. Reaction, strongly acid.

The rest of the profile is essentially the same as Zanesville silt loam.

Only a few areas of this phase are now cropped and the yields are very low. Tilth conditions are poor and fertility is extremely low. The less seriously eroded areas can be retained for cropping by proper management practices, which include liming, turning under large quantities of organic matter, and growing more hay and less clean-cultivated crops. Where gullies are numerous the best use is probably forest. The larger part of this phase has been abandoned and now supports a growth of poverty oatgrass, broomsedge, briers, and sassafras.

## ESTIMATED YIELDS AND PRODUCTIVITY RATINGS

In table 8 the soils are listed alphabetically and estimated average acre yields of the principal crops are given for each soil under both common and improved practices.

In order to compare directly the yields obtained in Johnson County with those obtained in other parts of the country, yield figures have been converted in table 9 to indexes based on standard yields.

The estimates in columns A under each crop indicate yields obtained under the prevailing practices, which, on most of the soils, include the use of small to moderate quantities of commercial fertilizers but generally do not include careful and intensive practices of soil management in regard to the control of erosion, the incorporation of organic matter, and the maintenance and increase of soil fertility and soil productivity. Yields under more careful and intensive practices are given in columns B. These practices consist of a regular crop rotation, including the growing of legumes where possible, the use of barnyard and green manures, the application of lime and liberal quantities of suitable commercial fertilizers, the installation of artificial drainage where necessary, the use of improved varieties and high-quality seed, and where needed, the use of such mechanical measures as contour tillage, strip cropping, and terracing or constructing diversion ditches for the control of erosion.

The estimates in table 8 are based primarily on interviews with farmers, the county agent, and members of the Purdue University Agricultural Experiment Station, on direct observation by members of the soil survey party, and on results obtained on experimental farms by the experiment station. They are presented only as estimates of the average production over a period of years, according to the two broadly defined types of management. It is realized that they may not apply directly to specific tracts for any particular year, as the soils shown on the map vary somewhat from place to place, management practices differ slightly from farm to farm, and climatic conditions fluctuate from year to year. On the other hand, these estimates are as accurate as can be obtained without further prolonged detailed investigations, and they serve to bring out the relative productivity of the soils mapped.

The soils are listed in table 9 by groups, conforming in general to the color groups on the soil map. The groups are arranged in the approximate order of their general productivity. The rating compares the productivity of each soil for each crop to a standard index—100. This standard represents the approximate average acre yield obtained without the use of amendments on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as the soil with the standard index. The standard yield for each crop except vegetables, apples, and pasture, is given at the head of the respective columns. Soils given amendments, as lime and commercial fertilizers; or special practices, as drainage and protective levees; and unusually productive soils have productivity indexes of more than 100 for some crops.

The indexes for vegetables, apples, and pasture are comparative only for the soils within the county, not conforming necessarily to standards set up for the country as a whole. Vegetables are important commercially, especially in the areas of Early Wisconsin and Late Wisconsin glacial drift. They are grown inextensively on the Cincinnati, Gibson, Avonburg, Zanesville, and Wellston soils. Apples are not an important crop. Because of the great variety of uses of pasture, the apparent lack of a well-planned program on many areas, and the extreme difficulty in

**Table 8.**—*Estimated average acre yields* [1] *of the principal crops on each soil in Johnson County, Ind.*

[Yields in columns A indicate the average crop obtained under prevailing practices, which include crop rotations, some erosion control practices, and the use of some legumes, commercial fertilizers, lime, and barnyard and green manures. Those in columns B indicate the average crop obtained with improved methods of management, which include the more intensive use of the prevailing practices. Absence of a yield figure indicates that the crop is not commonly grown]

| Soil [1] | Corn | | Wheat | | Oats | | Soybeans | | Mixed hay | | Red clover | | Alfalfa | | Potatoes | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| | *Bu.* | *Bu.* | *Bu* | *Bu* | *Bu* | *Bu* | *Bu* | *Bu* | *Tons* | *Tons* | *Tons* | *Tons* | *Tons* | *Tons* | *Bu.* | *Bu.* |
| Abington silty clay loam: | | | | | | | | | | | | | | | | |
| Drained | 45 | 55 | 17 | 25 | 37 | 45 | 22 | 25 | 2.2 | 2.5 | 1.6 | 2.0 | 2.8 | 3.6 | 150 | 180 |
| Undrained | 10 | ---- | ---- | ---- | 10 | ---- | 10 | ---- | 1.0 | ---- | 1.0 | ---- | ---- | ---- | ---- | |
| Avonburg silt loam: | | | | | | | | | | | | | | | | |
| Drained | 25 | 45 | 12 | 20 | 20 | 30 | 15 | 20 | 1.0 | 1.8 | .6 | 1.0 | ---- | ---- | 80 | 120 |
| Undrained | 15 | ---- | 7 | ---- | 15 | ---- | 10 | ---- | .6 | ---- | ---- | ---- | ---- | ---- | 50 | |
| Bellefontaine loam | 27 | 37 | 12 | 20 | 15 | 20 | 10 | 15 | 1.2 | 1.5 | .6 | 1.2 | 1.8 | 3.2 | 60 | 100 |
| Level phase | 30 | 40 | 14 | 17 | 18 | 23 | 12 | 18 | 1.4 | 1.8 | .7 | 1.4 | 2.0 | 3.5 | 70 | 110 |
| Bethel silt loam: | | | | | | | | | | | | | | | | |
| Drained | 25 | 30 | 10 | 15 | 20 | 25 | 10 | 15 | 1.2 | 1.6 | 8 | 1.4 | 1.2 | 2.4 | 60 | 100 |
| Undrained | 15 | ---- | 5 | ---- | 10 | ---- | 7 | ---- | .4 | ---- | .4 | ---- | ---- | ---- | 20 | |
| Brookston silty clay loam: | | | | | | | | | | | | | | | | |
| Drained | 50 | 60 | 18 | 25 | 37 | 47 | 22 | 25 | 2.2 | 2.5 | 1.8 | 2.0 | 3.0 | 3.8 | 150 | 180 |
| Undrained | 25 | ---- | 5 | ---- | 15 | ---- | 12 | ---- | 1.6 | ---- | 1.4 | ---- | 2.0 | ---- | 50 | |
| Carlisle silty muck: | | | | | | | | | | | | | | | | |
| Drained | 45 | 55 | 10 | 15 | 20 | 30 | 22 | 25 | 1.5 | 2.0 | 1.2 | 1.8 | 2.0 | 3.0 | 150 | 225 |
| Undrained | 10 | ---- | ---- | ---- | ---- | ---- | 10 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | |
| Cincinnati silt loam | 25 | 35 | 12 | 20 | 25 | 35 | 12 | 20 | .8 | 1.5 | .2 | 1.2 | ---- | ---- | 80 | 120 |
| Eroded phase | 20 | 30 | 10 | 15 | 20 | 30 | 10 | 15 | .6 | 1.2 | .2 | 1.0 | ---- | ---- | 60 | 80 |
| Shallow phase | 20 | 30 | 10 | 18 | 25 | 35 | 12 | 18 | 8 | 1.5 | 2 | 1.2 | ---- | ---- | 80 | 120 |
| Steep phase | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | |
| Clyde silty clay loam: | | | | | | | | | | | | | | | | |
| Drained | 45 | 55 | 17 | 25 | 37 | 45 | 22 | 25 | 2.2 | 2.5 | 1.6 | 2.0 | 2.8 | 3.6 | 150 | 180 |
| Undrained | 10 | ---- | ---- | ---- | 10 | ---- | 10 | ---- | 1.0 | ---- | 1.0 | ---- | ---- | ---- | ---- | |
| Crosby silt loam: | | | | | | | | | | | | | | | | |
| Drained | 35 | 45 | 15 | 20 | 30 | 40 | 20 | 25 | 1.8 | 2.5 | 1.4 | 1.8 | 2.4 | 3.2 | 100 | 140 |
| Undrained | 20 | ---- | 10 | ---- | 20 | ---- | 12 | ---- | 1.5 | ---- | 1.0 | ---- | 1.2 | ---- | 60 | |
| Delmar silt loam: | | | | | | | | | | | | | | | | |
| Drained | 25 | 30 | 10 | 15 | 20 | 25 | 10 | 15 | 1.0 | 1.6 | .8 | 1.4 | .8 | 2.4 | 60 | 100 |
| Undrained | 15 | ---- | 5 | ---- | 10 | ---- | 7 | ---- | .4 | ---- | .4 | ---- | ---- | ---- | 20 | |
| Eel loam: | | | | | | | | | | | | | | | | |
| Drained | 45 | 55 | 15 | 18 | 30 | 35 | 22 | 25 | 2.2 | 2.4 | 1.8 | 2.0 | 2.4 | 3.2 | 100 | 150 |
| Undrained | 40 | ---- | 10 | ---- | 20 | ---- | 20 | ---- | 1.4 | ---- | 1.4 | ---- | 1.6 | ---- | 60 | |
| Eel silt loam: | | | | | | | | | | | | | | | | |
| Drained | 50 | 60 | 15 | 18 | 30 | 35 | 22 | 25 | 2.2 | 2.5 | 1.8 | 2.0 | 2.4 | 3.2 | 100 | 150 |
| Undrained | 45 | ---- | 10 | ---- | 20 | ---- | 20 | ---- | 1.4 | ---- | 1.4 | ---- | 1.6 | ---- | 60 | |
| Eel silty clay loam: | | | | | | | | | | | | | | | | |
| Drained | 50 | 60 | 15 | 18 | 30 | 35 | 22 | 25 | 2.2 | 2.5 | 1.8 | 2.0 | 2.4 | 3.2 | 100 | 150 |
| Undrained | 45 | ---- | 10 | ---- | 20 | ---- | 20 | ---- | 1.4 | ---- | 1.4 | ---- | 1.0 | ---- | 60 | |
| Fincastle silt loam: | | | | | | | | | | | | | | | | |
| Drained | 35 | 45 | 15 | 20 | 30 | 35 | 20 | 25 | 1.8 | 2.2 | 1.4 | 1.8 | 2.4 | 3.2 | 100 | 140 |
| Undrained | 20 | ---- | 10 | ---- | 20 | ---- | 12 | ---- | 1.5 | ---- | 1.0 | ---- | 1.2 | ---- | 60 | |
| Fox loam | 30 | 40 | 20 | 25 | 25 | 30 | 15 | 20 | 1.4 | 2.0 | 1.0 | 1.4 | 2.4 | 3.6 | 80 | 100 |
| Sloping phase | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 8 | 1.6 | ---- | ---- | 1.6 | 2.4 | ---- | |
| Fox silt loam | 35 | 45 | 20 | 25 | 25 | 30 | 17 | 21 | 1.6 | 2.0 | 1.0 | 1.6 | 2.4 | 3.0 | 80 | 100 |
| Genesee fine sandy loam: | | | | | | | | | | | | | | | | |
| Protected | 35 | 40 | 12 | 18 | 30 | 35 | 20 | 22 | 1.2 | 1.5 | .8 | 1.2 | 2.4 | 3.2 | 100 | 120 |
| Unprotected | 30 | ---- | 5 | ---- | 10 | ---- | 15 | ---- | .8 | ---- | 6 | ---- | 1.6 | ---- | 60 | |
| Genesee loam: | | | | | | | | | | | | | | | | |
| Protected | 50 | 55 | 17 | 20 | 40 | 45 | 22 | 25 | 2.2 | 2.5 | 2.0 | 2.2 | 3.6 | 4.0 | 140 | 170 |
| Unprotected | 45 | ---- | 12 | ---- | 30 | ---- | 22 | ---- | 2.0 | ---- | 1.6 | ---- | 3.2 | ---- | 120 | |
| Genesee silt loam: | | | | | | | | | | | | | | | | |
| Protected | 55 | 60 | 20 | 22 | 40 | 45 | 22 | 25 | 2.2 | 2.5 | 2.0 | 2.2 | 3.6 | 4.0 | 140 | 170 |
| Unprotected | 50 | ---- | 12 | ---- | 30 | ---- | 22 | ---- | 2.0 | ---- | 1.6 | ---- | 3.2 | ---- | 120 | |
| Gibson silt loam | 25 | 35 | 12 | 20 | 25 | 35 | 12 | 20 | 1.0 | 1.5 | 2 | 1.2 | ---- | ---- | 80 | 120 |
| Homer silt loam: | | | | | | | | | | | | | | | | |
| Drained | 30 | 40 | 15 | 20 | 25 | 35 | 15 | 20 | 1.5 | 2.0 | 1.0 | 1.6 | 2.0 | 3.2 | 60 | 100 |
| Undrained | 20 | ---- | 10 | ---- | 20 | ---- | 10 | ---- | 1.2 | ---- | 6 | ---- | .8 | ---- | 40 | |
| Mahalasville silty clay loam: | | | | | | | | | | | | | | | | |
| Drained | 45 | 55 | 17 | 22 | 35 | 40 | 22 | 25 | 2.0 | 2.2 | 1.6 | 2.0 | 2.4 | 3.2 | 40 | 170 |
| Undrained | 25 | ---- | 5 | ---- | 15 | ---- | 12 | ---- | 1.4 | ---- | 1.2 | ---- | 1.6 | ---- | 40 | |
| Martinsville loam | 30 | 40 | 20 | 25 | 25 | 35 | 17 | 20 | 1.8 | 2.2 | 1.2 | 1.8 | 2.8 | 3.6 | 80 | 120 |
| Martinsville silt loam | 30 | 45 | 20 | 25 | 25 | 35 | 17 | 20 | 1.8 | 2.2 | 1.2 | 1.8 | 2.8 | 3.8 | 80 | 120 |
| Miami loam | 30 | 40 | 15 | 22 | 30 | 35 | 15 | 20 | 1.6 | 2.0 | 1.4 | 1.8 | 2.8 | 3.6 | 120 | 170 |
| Miami silt loam | 35 | 45 | 17 | 25 | 35 | 40 | 17 | 22 | 1.8 | 2.2 | 1.4 | 1.8 | 2.8 | 3.6 | 100 | 150 |
| Eroded phase | 25 | 35 | 12 | 18 | 20 | 30 | 12 | 16 | 1.4 | 2.0 | 1.0 | 1.6 | 2.0 | 3.5 | 80 | 125 |
| Gullied phase | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | |
| Sloping phase | 27 | 32 | 14 | 17 | 27 | 30 | 14 | 16 | 1.4 | 1.7 | 1.2 | 1.4 | 1.0 | 1.4 | ---- | |
| Muskingum stony silt loam [1] | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | |

See footnote at end of table.

TABLE 8.—*Estimated average acre yields* [1] *of the principal crops on each soil in Johnson County, Ind.*—Continued

| Soil [1] | Corn | | Wheat | | Oats | | Soybeans | | Mixed hay | | Red clover | | Alfalfa | | Potatoes | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| | *Bu* | *Bu* | *Bu* | *Bu* | *Bu* | *Bu.* | *Bu.* | *Bu* | *Tons* | *Tons* | *Tons* | *Tons* | *Tons* | *Tons* | *Bu.* | *Bu* |
| Nineveh loam | 35 | 45 | 20 | 25 | 25 | 30 | 17 | 21 | 1.6 | 2 0 | 1.0 | 1 6 | 2.4 | 3.6 | 80 | 100 |
| Philo silt loam | 40 | 45 | 15 | 20 | 20 | 30 | 17 | 22 | 1 8 | 2.0 | 6 | 1.2 | ----- | ----- | 100 | 150 |
| Pope silt loam | 40 | 45 | 12 | 20 | 20 | 30 | 17 | 22 | 1.8 | 2.0 | .6 | 1.2 | ----- | ----- | 100 | 150 |
| Princeton fine sandy loam | 20 | 30 | 10 | 15 | 10 | 20 | 12 | 15 | .5 | 1.0 | 2 | .6 | 2.0 | 3.2 | 100 | 150 |
| Ross silty clay loam | 45 | 50 | 17 | 22 | 35 | 40 | 22 | 25 | 2 2 | 2.4 | 1.8 | 2.0 | 1 2 | 1.6 | 120 | 160 |
| Russell silt loam | 35 | 45 | 17 | 25 | 35 | 45 | 17 | 22 | 1 8 | 2.2 | 1 2 | 1.8 | 2 4 | 3 6 | 100 | 150 |
| Eroded phase | 25 | 35 | 12 | 18 | 20 | 30 | 12 | 16 | 1.5 | 1.8 | 9 | 1.5 | 2.0 | 3.2 | 80 | 125 |
| Sloping phase | 27 | 32 | 14 | 17 | 22 | 27 | 14 | 18 | 1 4 | 1.7 | 9 | 1.4 | 2.0 | 2.8 | ---- | |
| Wellston silt loam | 15 | 25 | 7 | 12 | 15 | 25 | 10 | 12 | .8 | 1.2 | .2 | 1.0 | ----- | ----- | 60 | 80 |
| Westland silty clay loam: | | | | | | | | | | | | | | | | |
| Drained | 45 | 55 | 17 | 22 | 35 | 40 | 22 | 25 | 2.0 | 2.2 | 1.6 | 2 0 | 2.4 | 3 2 | 140 | 170 |
| Undrained | 25 | ---- | 5 | ---- | 15 | ---- | 12 | ---- | 1.4 | ----- | 1 2 | ----- | 1 6 | ----- | 40 | |
| Whitaker loam: | | | | | | | | | | | | | | | | |
| Drained | 30 | 40 | 15 | 20 | 25 | 35 | 15 | 20 | 1 5 | 2.0 | 1 0 | 1.6 | 2 0 | 3.2 | 60 | 100 |
| Undrained | 20 | ---- | 10 | ---- | 20 | ---- | 10 | ---- | 1.2 | ----- | .6 | ----- | .8 | ----- | 40 | |
| Whitaker silt loam: | | | | | | | | | | | | | | | | |
| Drained | 30 | 40 | 15 | 20 | 25 | 35 | 15 | 20 | 1.5 | 2 0 | 1.0 | 1.6 | 2 0 | 3.2 | 60 | 100 |
| Undrained | 20 | ---- | 10 | ---- | 20 | ---- | 10 | ---- | 1.2 | ----- | .6 | ----- | .8 | ----- | 40 | |
| Zanesville silt loam | 20 | 40 | 10 | 17 | 20 | 30 | 12 | 17 | 1 0 | 1.5 | .2 | 1.2 | ----- | ----- | 100 | 120 |
| Eroded phase | 15 | 25 | 8 | 14 | 15 | 22 | 10 | 15 | .7 | 1.0 | .2 | 1.0 | ----- | ----- | 60 | 80 |

[1] The terms "drained" and "undrained" have reference to artificial drainage; and "protected" and "unprotected" to the presence or absence of levees.

estimating cow-acre-days, or pounds of beef to the acre in a year, the ratings for pasture are inductive to a considerable degree and apply only within the county.

General productivity grade numbers are assigned in the column so designated. This grade is based on a weighted average of the indexes for the various crops, the weighting depending on relative acreage and value. If the weighted average is between 90 and 100, the soil is given a grade of 1; if between 80 and 90, a grade of 2; and so on. In instances in which the weighted average is above 100 and less than 110, a grade of 1+ is given. In Johnson County the grades are based largely on the indexes of the crops important on each soil. Because it is difficult to measure mathematically either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops, perhaps too much significance may be given to the general productivity grades.

The last column of table 9, "Use and physical suitability for use," gives additional information regarding the individual soils in relation to their use for agriculture.

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables show the relative productivity of individual soils. They cannot picture in a given county the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types used for each of the specified crops.

Economic considerations have played no part in determining the crop-productivity indexes. They cannot be interpreted, therefore, into land values, except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideration that determines the relative worth of a soil for grow-

TABLE 9.—*Productivity ratings of soils*

[Indexes indicate the approximate average production of each crop in percentage of the standard of reference, which types of those regions of the United States in which the crop is most widely grown, they are based largely on estimates obtained under prevailing practices, which include crop rotations, some erosion control practices, and the use to average yields obtained with improved methods of management, which include the more intensive

| Soil [1] | Crop productivity | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Corn (100=50 bu.) | | Wheat (100=25 bu.) | | Oats (100=50 bu.) | | Soybeans (100=25 bu.) | | Mixed hay (100=2 tons) | | Red clover (100=2 tons) | | Alfalfa (100=4 tons) | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| Dark poorly drained soils of the depressions | | | | | | | | | | | | | | |
| Brookston silty clay loam | | | | | | | | | | | | | | |
| Drained | 100 | 120 | 70 | 100 | 75 | 95 | 90 | 100 | 110 | 125 | 90 | 100 | 75 | 05 |
| Undrained | 50 | ----- | 20 | ----- | 30 | ----- | 50 | ----- | 80 | ----- | 70 | ----- | 50 | ----- |
| Westland silty clay loam | | | | | | | | | | | | | | |
| Drained | 100 | 120 | 70 | 95 | 75 | 90 | 90 | 100 | 100 | 110 | 80 | 100 | 70 | 85 |
| Undrained | 50 | ----- | 20 | ----- | 30 | ----- | 50 | ----- | 70 | ----- | 60 | ----- | 45 | ----- |
| Mahalasville silty clay loam | | | | | | | | | | | | | | |
| Drained | 90 | 110 | 70 | 90 | 70 | 80 | 90 | 100 | 100 | 110 | 80 | 100 | 60 | 8 |
| Undrained | 50 | ----- | 20 | ----- | 30 | ----- | 50 | ----- | 70 | ----- | 60 | ----- | 40 | ----- |
| Abington silty clay loam | | | | | | | | | | | | | | |
| Drained | 90 | 110 | 70 | 80 | 75 | 90 | 90 | 100 | 110 | 125 | 80 | 100 | 70 | 90 |
| Undrained | 20 | ----- | ----- | ----- | 20 | ----- | 40 | ----- | 50 | ----- | 50 | ----- | ----- | ----- |
| Clyde silty clay loam | | | | | | | | | | | | | | |
| Drained | 90 | 110 | 70 | 80 | 75 | 90 | 90 | 100 | 110 | 125 | 80 | 100 | 70 | 90 |
| Undrained | 20 | ----- | ----- | ----- | ----- | ----- | 40 | ----- | 50 | ----- | 50 | ----- | ----- | ----- |
| Organic soils | | | | | | | | | | | | | | |
| Carlisle silty muck | | | | | | | | | | | | | | |
| Drained | 90 | 110 | 40 | 60 | 40 | 60 | 90 | 100 | 75 | 100 | 60 | 90 | 50 | 75 |
| Undrained | 20 | ----- | ----- | ----- | ----- | ----- | 40 | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Alluvial soils (sweet) | | | | | | | | | | | | | | |
| Genesee silt loam | | | | | | | | | | | | | | |
| Protected | 110 | 120 | 80 | 90 | 80 | 90 | 90 | 100 | 110 | 125 | 100 | 110 | 90 | 100 |
| Unprotected | 100 | ----- | 50 | ----- | 60 | ----- | 90 | ----- | 100 | ----- | 80 | ----- | 80 | ----- |
| Genesee loam | | | | | | | | | | | | | | |
| Protected | 100 | 110 | 70 | 80 | 80 | 90 | 90 | 100 | 110 | 125 | 100 | 110 | 90 | 100 |
| Unprotected | 90 | ----- | 50 | ----- | 60 | ----- | 90 | ----- | 100 | ----- | 80 | ----- | 80 | ----- |
| Ross silty clay loam | 90 | 100 | 70 | 90 | 70 | 80 | 90 | 100 | 110 | 120 | 90 | 100 | 60 | 80 |
| Eel silt loam | | | | | | | | | | | | | | |
| Drained | 100 | 120 | 60 | 70 | 60 | 70 | 100 | 110 | 90 | 100 | 60 | 80 | 60 | 80 |
| Undrained | 90 | ----- | 40 | ----- | 40 | ----- | 70 | ----- | 70 | ----- | 40 | ----- | 40 | ----- |
| Eel loam | | | | | | | | | | | | | | |
| Drained | 90 | 110 | 60 | 70 | 60 | 70 | 90 | 100 | 110 | 120 | 90 | 100 | 60 | 80 |
| Undrained | 80 | ----- | 40 | ----- | 40 | ----- | 80 | ----- | 70 | ----- | 70 | ----- | 40 | ----- |
| Eel silty clay loam | | | | | | | | | | | | | | |
| Drained | 100 | 120 | 60 | 70 | 60 | 70 | 90 | 100 | 110 | 125 | 90 | 100 | 60 | 80 |
| Undrained | 90 | ----- | 40 | ----- | 40 | ----- | 80 | ----- | 70 | ----- | 70 | ----- | 40 | ----- |
| Genesee fine sandy loam | | | | | | | | | | | | | | |
| Protected | 70 | 80 | 50 | 70 | 60 | 70 | 80 | 90 | 60 | 75 | 40 | 60 | 60 | 80 |
| Unprotected | 60 | ----- | 20 | ----- | 20 | ----- | 60 | ----- | 40 | ----- | 30 | ----- | 40 | ----- |
| Alluvial soils (strongly acid): | | | | | | | | | | | | | | |
| Philo silt loam | 80 | 90 | 60 | 80 | 40 | 60 | 70 | 90 | 90 | 100 | 30 | 60 | ----- | ----- |
| Pope silt loam | 80 | 90 | 50 | 80 | 40 | 60 | 70 | 90 | 90 | 100 | 30 | 60 | ----- | ----- |
| Imperfectly drained soils of the uplands | | | | | | | | | | | | | | |
| Crosby silt loam | | | | | | | | | | | | | | |
| Drained | 70 | 90 | 60 | 80 | 60 | 80 | 80 | 100 | 90 | 110 | 70 | 90 | 60 | 80 |
| Undrained | 40 | ----- | 40 | ----- | 40 | ----- | 50 | ----- | 75 | ----- | 50 | ----- | 30 | ----- |
| Fincastle silt loam | | | | | | | | | | | | | | |
| Drained | 70 | 90 | 60 | 80 | 60 | 70 | 80 | 100 | 90 | 110 | 70 | 90 | 60 | 80 |
| Undrained | 40 | ----- | 40 | ----- | 40 | ----- | 50 | ----- | 75 | ----- | 50 | ----- | 30 | ----- |
| Avonburg silt loam | | | | | | | | | | | | | | |
| Drained | 50 | 90 | 50 | 80 | 40 | 60 | 60 | 80 | 50 | 90 | 30 | 50 | ----- | ----- |
| Undrained | 30 | ----- | 30 | ----- | 30 | ----- | 40 | ----- | 30 | ----- | ----- | ----- | ----- | ----- |
| Imperfectly drained soils of the glaciofluvial outwash plains and terraces | | | | | | | | | | | | | | |
| Whitaker silt loam: | | | | | | | | | | | | | | |
| Drained | 60 | 80 | 60 | 80 | 50 | 70 | 60 | 80 | 75 | 100 | 50 | 80 | 50 | 80 |
| Undrained | 40 | ----- | 40 | ----- | 40 | ----- | 40 | ----- | 60 | ----- | 30 | ----- | 20 | ----- |
| Whitaker loam | | | | | | | | | | | | | | |
| Drained | 60 | 80 | 60 | 80 | 50 | 70 | 60 | 80 | 75 | 100 | 50 | 80 | 50 | 80 |
| Undrained | 40 | ----- | 40 | ----- | 40 | ----- | 40 | ----- | 60 | ----- | 30 | ----- | 20 | ----- |
| Homer silt loam | | | | | | | | | | | | | | |
| Drained | 60 | 80 | 60 | 80 | 50 | 70 | 60 | 80 | 75 | 100 | 50 | 80 | 50 | 80 |
| Undrained | 40 | ----- | 40 | ----- | 40 | ----- | 40 | ----- | 60 | ----- | 30 | ----- | 20 | ----- |

See footnotes at end of table.

*in Johnson County, Ind.*

represents the approximate average yield obtained without the use of amendments on the more extensive and better soil of yields (see table 8), as yield data are too fragmental to be adequate Indexes in columns A refer to average yields of some legumes, commercial fertilizers, lime, and barnyard and green manures Those in columns B refer use of the prevailing practices. Absence of an index indicates that the crop is not commonly grown.]

| index for— | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Potatoes (100=200 bu.) | | Vegetables [3] | | Apples [2] | | Pasture [2] | | General productivity grade [3] | | Use and physical suitability for use |
| A | B | A | B | A | B | A | B | A | B | |
| 75 | 90 | 70 | 100 | ----- | ----- | 90 | 100 | 1 | 1+ | Largely used for grain and livestock farming A 3-year crop rotation of corn, wheat, or oats and legumes is common These soils in general are especially well suited for corn, soybeans, and truck crops. Fall-sown small grains and legumes are occasionally damaged by winter-killing and heaving. Crops grown on undrained areas are likely to be damaged by standing water |
| 25 | ----- | 30 | ----- | ----- | ----- | 80 | ----- | 5 | ----- | |
| 75 | 90 | 70 | 100 | ----- | ----- | 90 | 100 | 1 | 1+ | |
| 25 | ----- | 30 | ----- | ----- | ----- | 80 | ----- | 5 | ----- | |
| 70 | 85 | 70 | 90 | ----- | ----- | 90 | 100 | 2 | 1+ | |
| 20 | ----- | 30 | ----- | ----- | ----- | 80 | ----- | 6 | ----- | |
| 75 | 90 | 70 | 100 | ----- | ----- | 90 | 100 | 2 | 1+ | |
| ----- | ----- | ----- | ----- | ----- | ----- | 70 | ----- | 8 | ----- | |
| 75 | 90 | 70 | 100 | ----- | ----- | 90 | 100 | 2 | 1+ | |
| ----- | ----- | ----- | ----- | ----- | ----- | 70 | ----- | 8 | ----- | |
| 75 | 110 | 80 | 110 | ----- | ----- | 90 | 100 | 2 | 1+ | Largely used for grain and livestock farming. Corn and soybeans are the principal crops Well adapted to vegetables, especially potatoes and sweet corn. Some damage from early frosts. Very deficient in potash. |
| ----- | ----- | ----- | ----- | ----- | ----- | 80 | 90 | 8 | ----- | |
| 70 | 85 | 75 | 95 | 20 | 30 | 90 | 100 | 1 | 1+ | Largely used for grain farming. Corn is the principal crop, wheat is second in importance. A rotation of corn, wheat or oats, and legumes is generally followed on the Genesee and Ross soils. Corn is the principal crop on the Eel soils Crops on unprotected or undrained areas may be damaged by overflow. |
| 60 | ----- | 60 | ----- | ----- | ----- | 90 | ----- | 2 | ----- | |
| 70 | 85 | 75 | 95 | 20 | 30 | 90 | 100 | 1 | 1+ | |
| 60 | ----- | 60 | ----- | ----- | ----- | 90 | 100 | 2 | ----- | |
| 60 | 80 | 60 | 80 | ----- | ----- | 90 | 100 | 1 | 1+ | |
| 50 | 75 | 60 | 80 | ----- | ----- | 90 | 100 | 1 | 1+ | |
| 30 | ----- | 30 | ----- | ----- | ----- | 80 | ----- | 3 | ----- | |
| 50 | 75 | 60 | 80 | ----- | ----- | 90 | 100 | 2 | 1+ | |
| 30 | ----- | 30 | ----- | ----- | ----- | 80 | ----- | 3 | ----- | |
| 50 | 75 | 60 | 80 | ----- | ----- | 90 | 100 | 1 | 1+ | |
| 30 | ----- | 30 | ----- | ----- | ----- | 80 | ----- | 3 | ----- | |
| 50 | 60 | 40 | 50 | ----- | ----- | 80 | 90 | 4 | 3 | Largely used for general farming, corn and wheat being the principal crops A 3-year rotation of corn, wheat, and mixed clover and timothy is common Alfalfa is not adapted to these soils |
| 30 | ----- | ----- | ----- | ----- | ----- | 70 | 80 | 5 | ----- | |
| 50 | 75 | 40 | 60 | ----- | ----- | 50 | 70 | 3 | 1 | |
| 50 | 75 | 40 | 60 | ----- | ----- | 50 | 70 | 3 | 1 | |
| 50 | 70 | 40 | 60 | 40 | 50 | 80 | 90 | 3 | 1 | The Crosby and Fincastle soils are largely used for grain and livestock farming A 3-year rotation of corn, wheat or oats, and legumes is common. Well adapted to alfalfa when properly limed. The Avonburg soil is largely used for general farming although there is some specialization in dairying and poultry Corn and wheat are the principal crops. Not suited to alfalfa. |
| 30 | ----- | 20 | ----- | ----- | ----- | 70 | ----- | 6 | ----- | |
| 50 | 70 | 40 | 60 | 40 | 50 | 80 | 90 | 3 | 1 | |
| 30 | ----- | 20 | ----- | ----- | ----- | 70 | ----- | 6 | ----- | |
| 40 | 60 | 20 | 40 | ----- | ----- | 30 | 50 | 5 | 2 | |
| 25 | ----- | ----- | ----- | ----- | ----- | 25 | ----- | 7 | ----- | |
| 30 | 50 | 30 | 40 | ----- | ----- | 40 | 60 | 4 | 2 | Largely used for grain and livestock farming. A 3-year rotation of corn, wheat, and mixed hay is common. |
| 20 | ----- | 20 | ----- | ----- | ----- | 30 | ----- | 6 | ----- | |
| 30 | 50 | 30 | 40 | ----- | ----- | 40 | 60 | 4 | 2 | |
| 20 | ----- | 20 | ----- | ----- | ----- | 30 | ----- | 6 | ----- | |
| 30 | 50 | 40 | 60 | ----- | ----- | 40 | 60 | 4 | 2 | |
| 20 | ----- | 30 | ----- | ----- | ----- | 30 | ----- | 6 | ----- | |

See footnotes at end of table.

TABLE 9.—*Productivity ratings of soils*

| Soil[1] | Crop productivity | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Corn (100=50 bu.) | | Wheat (100=25 bu.) | | Oats (100=50 bu.) | | Soybeans (100=25 bu.) | | Mixed hay (100=2 tons) | | Red clover (100=2 tons) | | Alfalfa (100=4 tons) | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| Moderately well-drained soils of the uplands. | | | | | | | | | | | | | | |
| Gibson silt loam | 50 | 70 | 50 | 80 | 50 | 70 | 50 | 80 | 50 | 75 | 10 | 60 | ----- | ----- |
| Well-drained soils of the uplands | | | | | | | | | | | | | | |
| Miami silt loam | 70 | 90 | 70 | 100 | 70 | 80 | 70 | 90 | 90 | 110 | 70 | 90 | 70 | 90 |
| Russell silt loam | 70 | 90 | 70 | 100 | 70 | 80 | 70 | 90 | 90 | 110 | 60 | 90 | 60 | 90 |
| Miami loam | 60 | 80 | 60 | 90 | 60 | 70 | 60 | 80 | 80 | 100 | 70 | 90 | 70 | 90 |
| Zanesville silt loam | 40 | 70 | 40 | 70 | 40 | 60 | 50 | 70 | 50 | 75 | 10 | 60 | ----- | ----- |
| Cincinnati silt loam | 50 | 70 | 50 | 80 | 50 | 70 | 50 | 80 | 40 | 75 | 10 | 60 | ----- | ----- |
| Shallow phase | 40 | 60 | 40 | 70 | 50 | 70 | 50 | 70 | 40 | 75 | 10 | 60 | ----- | ----- |
| Wellston silt loam | 30 | 50 | 30 | 50 | 30 | 50 | 40 | 50 | 40 | 60 | 10 | 50 | ----- | ----- |
| Well-drained to excessively drained soils of the glaciofluvial outwash plains and terraces | | | | | | | | | | | | | | |
| Nineveh loam | 70 | 90 | 80 | 100 | 50 | 60 | 80 | 90 | 80 | 100 | 50 | 80 | 60 | 90 |
| Martinsville silt loam | 75 | 95 | 80 | 100 | 50 | 70 | 70 | 90 | 90 | 110 | 60 | 90 | 70 | 95 |
| Fox silt loam | 70 | 90 | 80 | 100 | 50 | 60 | 65 | 85 | 80 | 100 | 50 | 80 | 60 | 90 |
| Martinsville loam | 60 | 80 | 80 | 100 | 50 | 70 | 70 | 80 | 90 | 110 | 60 | 90 | 70 | 90 |
| Fox loam | 60 | 80 | 70 | 100 | 50 | 60 | 60 | 80 | 70 | 100 | 50 | 70 | 65 | 90 |
| Poorly drained soils of the uplands: | | | | | | | | | | | | | | |
| Bethel silt loam: | | | | | | | | | | | | | | |
| Drained | 50 | 60 | 40 | 60 | 40 | 50 | 40 | 60 | 60 | 80 | 40 | 70 | 30 | 60 |
| Undrained | 30 | ----- | 20 | ----- | 20 | ----- | 30 | ----- | 20 | ----- | 20 | ----- | ----- | ----- |
| Delmar silt loam | | | | | | | | | | | | | | |
| Drained | 50 | 60 | 40 | 60 | 40 | 50 | 40 | 60 | 50 | 80 | 40 | 70 | 20 | 60 |
| Undrained | 30 | ----- | 20 | ----- | 20 | ----- | 30 | ----- | 20 | ----- | 20 | ----- | ----- | ----- |
| Well to excessively drained soils of the uplands | | | | | | | | | | | | | | |
| Princeton fine sandy loam | 40 | 60 | 40 | 60 | 20 | 40 | 50 | 60 | 25 | 50 | 10 | 30 | 50 | 80 |
| Miami silt loam, eroded phase. | 60 | 80 | 60 | 80 | 50 | 70 | 60 | 80 | 80 | 100 | 60 | 80 | 60 | 80 |
| Russell silt loam, eroded phase | 60 | 80 | 60 | 80 | 50 | 70 | 60 | 80 | 80 | 100 | 50 | 80 | 50 | 80 |
| Bellefontaine loam, level phase. | 55 | 80 | 50 | 80 | 30 | 40 | 60 | 80 | 60 | 75 | 30 | 60 | 60 | 85 |
| Bellefontaine loam | 55 | 75 | 50 | 80 | 30 | 40 | 60 | 80 | 60 | 75 | 30 | 60 | 60 | 85 |
| Miami silt loam, sloping phase | 55 | 65 | 55 | 70 | 55 | 60 | 55 | 65 | 70 | 85 | 55 | 70 | 50 | 70 |
| Russell silt loam, sloping phase | 55 | 65 | 55 | 70 | 45 | 55 | 55 | 65 | 70 | 85 | 45 | 70 | 50 | 70 |
| Zanesville silt loam, eroded phase | 30 | 60 | 30 | 60 | 30 | 50 | 40 | 60 | 40 | 60 | 10 | 50 | ----- | ----- |
| Cincinnati silt loam, eroded phase | 35 | 50 | 30 | 60 | 30 | 50 | 40 | 60 | 30 | 60 | 10 | 50 | ----- | ----- |
| Miami silt loam, gullied phase | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Excessively drained soils of the uplands | | | | | | | | | | | | | | |
| Cincinnati silt loam, steep phase | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Muskingum stony silt loam. | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Excessively drained soils of the glaciofluvial outwash plains and terraces | | | | | | | | | | | | | | |
| Fox loam, sloping phase | 25 | 40 | 25 | 40 | ----- | ----- | ----- | ----- | 30 | 50 | 20 | 35 | 40 | 60 |

[1] The terms "drained" and "undrained" have reference to artificial drainage, and "protected" and "unprotected" to the presence or absence of levees

[2] Indexes for vegetables, apples, and pasture are only relative for the county and because of a lack of data do not refer to the standard of reference.

*in Johnson County, Ind.*—Continued

| index for— | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Potatoes (100=200 bu.) | | Vegetables [2] | | Apples [2] | | Pasture [2] | | General productivity grade [3] | | Use and physical suitability for use |
| A | B | A | B | A | B | A | B | A | B | |
| 40 | 60 | 30 | 50 | 50 | 60 | 30 | 50 | 5 | 3 | General farming and some specialization in dairying. The principal rotation is corn, wheat, and mixed hay. |
| 50 | 75 | 40 | 70 | 60 | 70 | 80 | 100 | 3 | 1 | The Miami and Russell soils are used chiefly for grain and livestock farming 3- to 5-year rotations including corn, wheat or oats, soybeans, and legumes are commonly followed. Alfalfa and clover are well adapted. The Cincinnati soils are used for general farming and to a limited extent for dairying and orchards; a rotation of corn, wheat, and mixed hay is common. The Wellston and Zanesville silt loams are used for general farming, with some specialization in orchards Corn and wheat are the principal crops. In general, the Wellston soil is better suited to forests. |
| 50 | 75 | 40 | 70 | 60 | 70 | 80 | 100 | 3 | 1 | |
| 50 | 75 | 40 | 70 | 60 | 70 | 80 | 100 | 3 | 1 | |
| 50 | 60 | 40 | 50 | 40 | 60 | 40 | 60 | 5 | 3 | |
| 40 | 60 | 30 | 50 | 50 | 60 | 40 | 60 | 6 | 3 | |
| 40 | 60 | 30 | 50 | 50 | 60 | 40 | 60 | 6 | 4 | |
| 30 | 40 | 20 | 40 | 30 | 40 | 30 | 40 | 7 | 5 | |
| 40 | 60 | 50 | 80 | 40 | 50 | 60 | 80 | 3 | 1 | Chiefly used for grain and livestock farming. 3- to 4-year rotations of corn, wheat, soybeans, and legumes are usually followed The Martinsville soils are well suited to alfalfa |
| 40 | 60 | 50 | 80 | 40 | 50 | 60 | 80 | 3 | 1 | |
| 40 | 60 | 50 | 80 | 40 | 50 | 60 | 80 | 3 | 1 | |
| 40 | 60 | 50 | 80 | 40 | 50 | 60 | 80 | 3 | 1 | |
| 40 | 50 | 50 | 80 | 40 | 50 | 60 | 80 | 4 | 2 | |
| 30 | 50 | 30 | 50 | ----- | ----- | 50 | 60 | 6 | 4 | Chiefly used for grain and livestock farming. The principal crops are corn, wheat, oats, soybeans, mixed hay, and alfalfa |
| 10 | ----- | 10 | ----- | ----- | ----- | 40 | ----- | 7 | ----- | |
| 30 | 50 | 30 | 50 | ----- | ----- | 50 | 60 | 6 | 4 | |
| 10 | ----- | 10 | ----- | ----- | ----- | 40 | ----- | 7 | ----- | |
| 50 | 75 | 50 | 100 | 50 | 70 | 30 | 40 | 6 | 2 | The Princeton soil is used for mixed grain and livestock farming, with melons and orchard fruits important special crops The sloping and eroded phases are used primarily for pasture and timber although certain of the soils, as the Miami, Bellefontaine, and Russell, may be used for long rotations, including a predominance of legumes in a system of grain and livestock farming. Some areas are used also for orchards |
| 40 | 60 | 30 | 60 | 50 | 60 | 60 | 90 | 4 | 2 | |
| 40 | 60 | 30 | 60 | 50 | 60 | 60 | 90 | 4 | 2 | |
| 30 | 50 | 40 | 70 | 40 | 50 | 50 | 70 | 5 | 3 | |
| 30 | 50 | 40 | 70 | 40 | 50 | 50 | 70 | 5 | 3 | |
| ----- | ----- | ----- | ----- | 50 | 60 | 70 | 80 | 5 | 3 | |
| ----- | ----- | ----- | ----- | 50 | 60 | 70 | 80 | 5 | 3 | |
| ----- | ----- | ----- | ----- | 35 | 55 | 30 | 50 | 6 | 4 | |
| ----- | ----- | ----- | ----- | 45 | 55 | 30 | 50 | 6 | 4 | |
| ----- | ----- | ----- | ----- | ----- | ----- | 10 | 15 | 10 | ----- | |
| ----- | ----- | ----- | ----- | ----- | ----- | 10 | 15 | 10 | ----- | Generally unsuited to cultivation; limited almost entirely to forestry. |
| ----- | ----- | ----- | ----- | ----- | ----- | 10 | 15 | 10 | ----- | |
| ----- | ----- | ----- | ----- | ----- | ----- | 40 | 60 | 8 | 6 | Used to a limited extent for corn, wheat, and hay. Steeper slopes suitable for pasture and forest but not for cultivated crops. |

[3] Numbers indicate the general productivity of the soils for the common crops under the two general levels of management outlined in the headnote. Refer to the text for further explanation regarding their determination by the weighting of individual crop indexes.

TABLE 10.—*Some characteristics that influence the suitability of soils for growing crops in Johnson County, Ind*

| Soil | Relief | Susceptibility to erosion under cultivation | Internal drainage | Reaction |
|---|---|---|---|---|
| Abington silty clay loam | Depressions | Very slight to none | Poor to very poor | Neutral to slightly acid |
| Avonburg silt loam | Nearly level | Very slight | Poor | Strong to very strongly acid |
| Bellefontaine loam | Undulating to sloping | Moderate to severe | Excessive | Slight to medium acid. |
| Level phase | Nearly level | Slight | do | Do. |
| Bethel silt loam | do | Very slight | Very poor | Medium to strongly acid |
| Brookston silty clay loam | Depressions in upland | None to very slight | do | Neutral to slightly acid. |
| Carlisle silty muck | Depressions | None to very slight (some wind erosion) | do | Slight to medium acid |
| Cincinnati silt loam | Undulating to sloping | Severe to very severe | Good | Strongly acid. |
| Eroded phase | Moderate to strongly sloping | do | do | Do. |
| Shallow phase | Undulating to sloping | do | do | Do. |
| Steep phase | Steep to very steep | Very severe to gully | Good to excessive | Do. |
| Clyde silty clay loam | Depressions in upland | None to very slight | Very poor | Neutral to slightly acid. |
| Crosby silt loam | Gently undulating to nearly level | None to slight | Poor to imperfect | Slight to medium acid. |
| Delmar silt loam | Nearly level | None to very slight | Very poor | Medium to strongly acid |
| Eel loam | Level or depressed | None | Poor to fair | Neutral. |
| Eel silt loam | do | do | do | Do. |
| Eel silty clay loam | do | do | do | Do. |
| Fincastle silt loam | Nearly level to gently undulating | None to slight | Poor to imperfect | Medium to strongly acid |
| Fox loam | do | Very slight | Excessive | Slight to medium acid |
| Sloping phase | Sloping to steep | Moderate to severe | do | Do. |
| Fox silt loam | Nearly level to gently undulating | Very slight | Good to excessive | Do |
| Genesee fine sandy loam | Nearly level | None to slight | Good | Neutral to slightly alkaline. |
| Genesee loam | do | do | do | Do |
| Genesee silt loam | do | do | do | Do. |
| Gibson silt loam | Gently undulating | Slight | Fair upper, restricted lower. | Strong to very strongly acid. |
| Homer silt loam | Nearly level to gently undulating | Slight to none | Imperfect to poor | Medium to slightly acid |
| Mahalasville silty clay loam | Depressed | None to slight | Very poor | Neutral |
| Martinsville loam | Nearly level to undulating | Slight to moderate | Good | Slight to medium acid |
| Martinsville silt loam | do | do | do | Do. |
| Miami loam | Undulating to gently sloping | Moderate to severe | do | Do |
| Miami silt loam | do | do | do | Do |
| Eroded phase | Undulating to strongly sloping | do | do | Do |
| Gullied phase | Sloping to strongly sloping | Severe gully erosion | do | Do |
| Sloping phase | Sloping | Severe to very severe | do | Do |
| Muskingum stony silt loam. | Steep slopes | Severe | do | Strongly acid |
| Nineveh loam | Nearly level to gently undulating | Very slight | Good to excessive | Slightly acid to neutral. |

See footnotes at end of table.

TABLE 10.—*Some characteristics that influence the suitability of soils for growing crops in Johnson County, Ind.*—Continued

| Soil | Approximate lime requirement | General productivity group [1] A | General productivity group [1] B | Factors limiting use |
|---|---|---|---|---|
| | *Tons* | | | |
| Abington silty clay loam | None | High [2]<br>Low [3] | Very high [2] | Poor drainage, potash deficiency |
| Avonburg silt loam | 3-5 | Medium [3]<br>Low [2] | Medium [2] | Puddling and baking, poor drainage, acidity, low organic content, low general fertility |
| Bellefontaine loam | 1-2 | Low to medium | Medium to high | Erosion, droughtiness, low organic content, low fertility |
| Level phase | 1-2 | do | do | Droughtiness, low organic content, low fertility |
| Bethel silt loam | 1-2 | Medium to low [2]<br>Medium to low [3] | Medium [2] | Puddling, poor drainage, low organic content |
| Brookston silty clay loam | None | Very high [2]<br>Medium [3] | Very high [2] | Poor drainage, potash deficiency |
| Carlisle silty muck | 0-2 | Very high [2]<br>Low [3] | Very high [2] | Poor drainage, potash and phosphate deficiency. |
| Cincinnati silt loam | 3-4 | Medium to low | Medium | Susceptibility to erosion, strong acidity, low organic content, low general fertility |
| Eroded phase | 3-4 | Low | Medium to low | Do |
| Shallow phase | 3-4 | Medium to low | Medium | Do |
| Steep phase | 3-4 | Very low | Very low | Nonarability, severe erosion, steep slope, low general fertility |
| Clyde silty clay loam | None | High [2]<br>Low [3] | Very high [2] | Poor drainage, potash deficiency |
| Crosby silt loam | 1-2 | High [2]<br>Medium to low [3] | Very high [2] | Imperfect drainage, low organic content |
| Delmar silt loam | 1-3 | Medium to low [2]<br>Medium to [3] | Medium [2] | Do |
| Eel loam | None | High [2]<br>High [3] | Very high [2] | Overflow and backwater damage |
| Eel silt loam | do | Very high [2]<br>High [3] | Very high [2] | Do |
| Eel silty clay loam | do | Very high [2]<br>High [3] | Very high [2] | Do. |
| Fincastle silt loam | 1-3 | High [2]<br>Medium to low [3] | Very high [2] | Imperfect drainage, low organic content |
| Fox loam | 1-2 | Medium | High | Droughtiness, low organic content |
| Sloping phase | 1-2 | Very low | | Droughtiness, slope, low general fertility |
| Fox silt loam | 1-2 | High | Very high | Droughtiness, low organic content |
| Genesee fine sandy loam | None | Medium [4]<br>Medium [5] | High [4] | Overflow |
| Genesee loam | do | Very high [4]<br>High [5] | Very high [4] | Do |
| Genesee silt loam | do | Very high [4]<br>High [5] | Very high [4] | Do |
| Gibson silt loam | 3-4 | Medium to low | Medium | Strong acidity, low organic content, low general fertility |
| Homer silt loam | 1-2 | Medium [2]<br>Medium to low [3] | High [2] | Imperfect drainage, low organic content. |
| Mahalasville silty clay loam. | None | Very high [2]<br>Medium to high [3] | Very high [2] | Poor drainage |
| Martinsville loam | 1-2 | High | Very high | Low organic content. |
| Martinsville silt loam | 1-2 | do | do | Do |
| Miami loam | 1-2 | do | do | Erosion, low organic content. |
| Miami silt loam | 1-2 | do | do | Do |
| Eroded phase | 1-2 | Low | Medium | Erosion, low general fertility. |
| Gullied phase | 1-2 | Very low | Very low | Erosion, low fertility |
| Sloping phase | 1-2 | Medium | High | Erosion, low organic content. |
| Muskingum stony silt loam | 2-3 | Very low | | Nonarability, steep slope. |
| Nineveh loam | 0-1 | Medium | High | Droughtiness |

See footnotes at end of table.

TABLE 10.—*Some characteristics that influence the suitability of soils for growing crops in Johnson County, Ind.*—Continued

| Soil | Relief | Susceptibility to erosion under cultivation | Internal drainage | Reaction |
|---|---|---|---|---|
| Philo silt loam | Nearly level | None to slight | Fair | Strong to very strongly acid |
| Pope silt loam | do | do | Good | Do |
| Princeton fine sandy loam | Undulating to sloping | Slight to severe (wind) | Excessive | Slight to medium acid. |
| Ross silty clay loam | Nearly level | None to slight | Good | Neutral to slightly acid |
| Russell silt loam | Undulating to gently sloping. | Moderate to severe | do | Medium to strongly acid |
| Eroded phase | Gently sloping to sloping. | do | do | Do. |
| Sloping phase | Sloping | Severe to very severe. | do | Do |
| Wellston silt loam | Undulating to sloping | Moderate to severe | do | Strong to very strongly acid |
| Westland silty clay loam | Depressions | None to very slight | Poor | Neutral |
| Whitaker loam | Nearly level | Slight to none | do | Slight to medium acid |
| Whitaker silt loam | do | do | do | Do |
| Zanesville silt loam | Undulating to gently sloping | Moderate to severe | Good | Strongly acid |
| Eroded phase | Gently sloping to sloping. | Moderate to very severe. | do | Do |

[1] General productivity is given here in descriptive terms The terms in columns A refer to the general productivity under prevailing practices, methods which include crop rotations, some erosion control practices, the use of some legumes, commercial fertilizers, lime, and barnyard and green manures Those in columns B refer to the general productivity under improved methods of management, which include the more intensive use of the prevailing practices

TABLE 11.—*Present uses of the soils in Clark and Pleasant Townships, Johnson County, Ind.* [1]

| Soil | Corn | Oats | Wheat | Rye | Soybeans | Unidentified cropland | Sweetclover | Truck crops | Red clover | Mixed hay |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| Abington silty clay loam | 12.2 | 6 1 | 23 2 | [5] | [5] | 1 2 | [5] | 4 9 | 14 6 | 7.3 |
| Bellefontaine loam | 27 2 | 2 3 | 19 6 | 1.0 | [5] | 1 2 | 2 2 | 3 6 | 9 0 | 2.0 |
| Level phase | 66 7 | [5] | [5] | [5] | [5] | 33.3 | [5] | [5] | [5] | [5] |
| Bethel silt loam | 20.6 | 14 7 | 44 1 | 5 9 | [5] | 5 9 | [5] | [5] | 3 0 | [5] |
| Brookston silty clay loam | 34 3 | 6.2 | 20.6 | .7 | 2.0 | 1 6 | 0 9 | 5 9 | 5 0 | 4.3 |
| Clyde silty clay loam | 40 6 | 10.3 | 17.3 | [5] | [5] | 1 4 | [5] | 2 2 | 5 1 | .7 |
| Crosby silt loam | 26 1 | 6.4 | 22.7 | .7 | 2 5 | .9 | 1 0 | 6 0 | 4 7 | 4.3 |
| Eel silt loam | 30 9 | 4 5 | 6 2 | .4 | [5] | 4 | 2 6 | 8 | 4 | 3.0 |
| Eel silty clay loam | 10 1 | 7.0 | 20 0 | [5] | 2 3 | [5] | [5] | 7.2 | 4 7 | 8.1 |
| Fox loam | 34 4 | 1 3 | 13 8 | [5] | 1 7 | [5] | [5] | 1.7 | 8.2 | 5.6 |
| Sloping phase | [5] | 14 3 | 43 0 | [5] | [5] | [5] | [5] | [5] | [5] | [5] |
| Fox silt loam | 27.9 | 4 3 | 21 3 | [5] | 6 2 | [5] | [5] | [5] | 17 7 | 3.3 |
| Genesee silt loam | 43.6 | 3.6 | 6 8 | [5] | 1 0 | [5] | 3 1 | 1.3 | 1 3 | [5] |
| Homer silt loam | 52 2 | 1.0 | 10 3 | [5] | 2 5 | [5] | [5] | 4 | 11 1 | 5.5 |
| Mahalasville silty clay loam | 38 0 | 4.8 | 14 6 | .3 | [5] | [5] | [5] | 2 2 | 17 3 | 4 3 |
| Martinsville loam | 43.3 | [5] | 9 1 | [5] | [5] | [5] | [5] | [5] | 11.6 | 3.6 |
| Martinsville silt loam | 11.0 | 1 0 | 28 0 | [5] | [5] | [5] | [5] | 2.0 | 11.0 | 8.0 |
| Miami loam | 30.0 | [5] | 4.2 | [5] | [5] | [5] | [5] | 12 7 | 25.5 | [5] |
| Miami silt loam | 36 6 | 5 2 | 18 0 | 1 | 3 3 | .1 | 1 0 | 3 6 | 5 4 | 3.8 |
| Eroded phase | 26 5 | 2 0 | 29 5 | 6 | 1 8 | 3 0 | [5] | 3 6 | 2 4 | 7.2 |
| Sloping phase | 16.5 | 5 5 | 12 5 | 1 0 | [5] | [5] | 3 5 | 2 0 | [5] | 3 5 |
| Westland silty clay loam | 40.1 | 2.7 | 15 7 | 6 | 6 | 1 2 | .1 | [5] | 10 4 | 2.9 |
| Whitaker loam | 51.3 | 7 1 | 5 1 | [5] | [5] | [5] | 2 0 | 2.0 | [5] | 4.0 |
| Whitaker silt loam | 31.0 | 1.3 | 18 0 | [5] | [5] | 4.0 | [5] | 8 1 | 13 4 | 4.0 |

[1] Use data collected by survey party during the field mapping of soils (1938).
[2] First-grade pasture includes areas having 75 percent or more of bluegrass and white clover; second-grade, less than 75 percent bluegrass and white clover

TABLE 10.—*Some characteristics that influence the suitability of soils for growing crops in Johnson County, Ind.*—Continued

| Soil | Approximate lime requirement | General productivity group [1] | | Factors limiting use |
|---|---|---|---|---|
| | | A | B | |
| Philo silt loam | 2-3 | Medium | High | Overflow, acidity, low fertility |
| Pope silt loam | 2-3 | do | do | Do |
| Princeton fine sandy loam | 1-3 | Medium to low | Medium to high | Droughtiness, low fertility, low organic content |
| Ross silty clay loam | None | Very high | Very high | Occasional overflow |
| Russell silt loam | 1-3 | High | do | Erosion, low organic content |
| Eroded phase | 1-3 | Medium | Medium to high | Erosion, low general productivity level |
| Sloping phase | 1-3 | do | High | Erosion, low organic content |
| Wellston silt loam | 3-4 | Medium to low | Medium | Erosion, acidity, low fertility. |
| Westland silty clay loam | None | Very high [2]<br>Low [3] | Very high [2] | Poor drainage, potash deficiency. |
| Whitaker loam | 1-2 | Medium [2]<br>Medium to low [3] | High [2] | Imperfect drainage, low organic content |
| Whitaker silt loam | 1-2 | Medium [2]<br>Medium to low [3] | High [2] | Do |
| Zanesville silt loam | 3-4 | Medium to low. | Medium | Erosion, acidity, low fertility |
| Eroded phase | 3-4 | Very low | Low | Do. |

[2] Artificially drained
[3] No artificial drainage
[4] Protected from overflow by levee
[5] Unprotected from overflow by levee

TABLE 11.—*Present uses of the soils in Clark and Pleasant Townships, Johnson County, Ind.* [1]—Continued

| Soil | Alfalfa | Miscellaneous hay crops | First-grade pasture [2] | Second-grade pasture [2] | Wooded pasture | Idle land [3] | Timber | Fruit trees | Other uses [4] |
|---|---|---|---|---|---|---|---|---|---|
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| Abington silty clay loam | (5) | (5) | 1.2 | (5) | 6 1 | (5) | 23 2 | (5) | (5) |
| Bellefontaine loam | 2.0 | (5) | 6. 5 | 6 3 | 3.3 | .5 | 4 5 | 3 0 | 5.8 |
| Level phase | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) |
| Bethel silt loam | (5) | (5) | (5) | (5) | 3.0 | (5) | (5) | (5) | 2.8 |
| Brookston silty clay loam | 1 2 | (5) | 6.1 | 2 0 | (5) | (5) | 2 0 | 5 | 6.7 |
| Clyde silty clay loam | (5) | (5) | 2 2 | 3.0 | (5) | 13 6 | 3 6 | (5) | (5) |
| Crosby silt loam | 1 4 | (5) | 7.3 | 3.9 | 2 6 | (5) | 3 3 | .8 | 5 4 |
| Eel silt loam | (5) | (5) | 23.7 | 6.2 | 12.5 | (5) | 6.2 | (5) | 3.5 |
| Eel silty clay loam | (5) | (5) | 2.2 | 19.5 | 11.2 | (5) | (5) | (5) | 2 2 |
| Fox loam | 4.8 | (5) | 10 0 | 4.8 | .9 | (5) | 3 5 | (5) | 9:3 |
| Sloping phase | (5) | (5) | 7 1 | 7.1 | (5) | 7.1 | 14 3 | 7 1 | (5) |
| Fox silt loam | 3 | (5) | 4 9 | 3 | 4.3 | (5) | 4 6 | (5) | 3.2 |
| Genesee silt loam | (5) | 15 9 | (5) | (5) | 1 3 | (5) | 12 2 | (5) | 9.9 |
| Homer silt loam | 2.6 | .8 | 9 0 | (5) | 3 8 | (5) | .8 | (5) | (5) |
| Mahalasville silty clay loam | 8 | (5) | 5 7 | 1 2 | 4 8 | 5 | 8 | .6 | 4 1 |
| Martinsville loam | 9 | (5) | 24 1 | (5) | (5) | (5) | 9 | (5) | 6 5 |
| Martinsville silt loam | 8 0 | (5) | 31 0 | (5) | (5) | (5) | (5) | (5) | (5) |
| Miami loam | 4 2 | (5) | 21.3 | (5) | 2 1 | (5) | (5) | (5) | (5) |
| Miami silt loam | .8 | (5) | 7 3 | 5 8 | 3.9 | (5) | 3.3 | 1.1 | .7 |
| Eroded phase | (5) | (5) | 6 0 | 6.6 | 1 2 | (5) | 5 4 | 1.8 | 2.4 |
| Sloping phase | (5) | (5) | 24.5 | 5 5 | (5) | 5 | 11 5 | .5 | 13.0 |
| Westland silty clay loam | 3.0 | (5) | 9.1 | 1 2 | 1 1 | 1.2 | 2 7 | .1 | 7.9 |
| Whitaker loam | (5) | (5) | 19 5 | (5) | 3.0 | 2.0 | (5) | (5) | 4 0 |
| Whitaker silt loam | 8 0 | (5) | (5) | (5) | 6 9 | (5) | (5) | (5) | 5 3 |

[3] Idle land includes arable land not under cultivation
[4] Includes all other crops and uses
[5] Less than 0.1 percent of the total area in a given use.

ing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained are examples of other considerations than productivity, which influence the general desirability of a soil for agricultural use. In turn, steepness of slope, presence or absence of stones, the resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristics that influence the relative ease with which soils can be tilled. Likewise, inherent fertility and susceptibility to erosion are characteristics that influence ease in maintaining soil productivity at a given level. Productivity, as measured by yields, is influenced to some degree by all these and other factors, including the moisture-holding capacity of the soil and its permeability to roots and water, and so these are not factors to be considered entirely separate from productivity. On the other hand, schemes of land classification to designate the relative suitability of land for agriculture generally give some separate recognition to them.

Table 10 gives some of the characteristics that influence the suitability of the soils for growing crops.

The relief of a soil very often is the principal factor that determines the use that can be made of it and largely governs the yields that can be obtained. Although the susceptibility of a soil to erosion may not necessarily control its use, it does have a great influence on the maintenance of productivity. Again, the internal drainage condition may be the principal factor influencing productivity. The larger part of the areas of the imperfectly drained, poorly drained, and very poorly drained soils has been sufficiently drained artificially to permit the growing of the common farm crops. The pH value of a soil is usually an indication of its lime requirement, although, in general, lighter textured soils require less lime than heavier textured ones having the same pH value.

The percentage of the soils of Clark and Pleasant Townships in Johnson County, according to their present uses are given in table 11.

These data, obtained at the time of the survey (1938), were compiled by the Purdue University Agricultural Experiment Station. While these data represent the record of only 1 year's crop, they do give an indication of how the various soils are being used. The cereals and hays were mapped regardless of the quality of the crop. Pasture was divided into two groups, depending upon the quality and estimated percentage of bluegrass present. First-grade pastures include areas where 75 percent or more of the cover is bluegrass or a mixture of bluegrass and white clover; second-grade, less than 75 percent bluegrass or white clover. Wooded pasture includes areas with a somewhat sparse tall growth where trees are far enough apart to permit a fair to good growth of bluegrass, and where natural reproduction is not developing. Idle land includes areas or fields that are arable but not in cultivation. The forested areas are grouped under the heading "Timber," which include all types of specie associations. Under the heading "Other uses" are included minor crops that are of small extent and relatively unimportant.

## FORESTS

The various forested areas are described under Vegetation. The three main timber types, or associations, are beech-maple, oak-hickory, and bottom-land.

The beech-maple type, originally the most extensive, covered most of the eastern and northern parts of the county, principally in the Early

Wisconsin and Late Wisconsin glacial drift regions. These areas, having little slope, are suited principally to agriculture. Probably less than 10 percent has a timber cover, most of which occurs on nonarable slopes. The most valuable commercial species—tuliptree (yellow-poplar), maple, and walnut—have been cut, leaving little timber of commercial value. Most areas of arable farm woodland and the woodland on steep slopes are being pastured, preventing the natural regeneration of timber cover; consequently, the thickness of the timber stand gradually declines as the trees mature. Probably most of the woodland in this area will eventually be converted to cropland and pasture.

The oak-hickory type is most extensive in the southwestern part of the county, in the regions of Illinoian drift and Borden sandstone, siltstone, and shale. Many of the narrow ridge tops, which were formerly cleared and cultivated, are now being abandoned because of low productivity and of susceptibility to erosion. These areas are covered with briers, persimmon, and sassafras, and will eventually revert to forest.

The bottom-land forest types grow mainly along stream channels, old bayous, and poorly drained areas, covering a total area of probably less than 2 percent, and little change is expected in the status of these forested areas.

At present little attention is given to silvicultural practices that would increase the returns from forest land, although increasing numbers of woodland areas are being classified under a State law provided for assessment at $1 an acre. When classified, areas must be fenced, adequately stocked, and not pastured. The trees on many woodland areas are cut as soon as they reach tie size. In scattered areas, however, they usually are cut at maturity. A few portable commercial sawmills are in use.

Potential forest land lies mainly in the southwestern part of the county, in the regions of Illinoian drift and Borden sandstone, siltstone, and shale. Long narrow ridge tops are common in this area, and on them many small irregular-shaped fields and farms have a small proportion of cropland. These factors, together with low productivity and increasing erosion, should result in increased use of this land for forest.

Elsewhere in the county, trees might be more extensively grown for reclamation on seriously eroded areas. Because of the small proportion of land suitable for cropping, these and similar areas might be used almost entirely for forest. Recently, interest in wild life conservation has become more active. Of the methods that might be used to improve forest management, the exclusion of livestock, selective cutting, and planting of adapted species offer the greatest possible returns. The practice of pasturing woodlands yields little return, as 6 to 10 acres is required to support an animal unit on the strongly acid nonfertile soils. Bluegrass is not adapted to the acid soils most extensively used for forest. Considerable damage to the young trees and prevention of the growth of most seedlings are caused by livestock.

## MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil;

(4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Johnson County lies in the region of Gray-Brown Podzolic [10] soils of the east-central part of the United States. Most of the soils have developed under a heavy forest cover of deciduous trees, with sufficient rainfall to wet the soil to an indefinite depth, so that a moist condition, except in short periods, is maintained throughout the soil. The climatic and biological conditions permit only a relatively thin surface accumulation of organic litter and a few inches of dark-colored soil in the upper part of the profile. The surface layer of organic matter is thinner than in the Podzol region to the north but thicker than in the Red and Yellow Podzolic region to the south. All except some of the poorly drained soils are light-colored and relatively low in organic content and vary from medium to strongly acid in the solum.

There are four different geologic formations or sources of material from which the parent material is derived in this county—(1) Late Wisconsin glacial drift; (2) Early Wisconsin glacial drift; (3) Illinoian glacial drift; and (4) Borden or Knobstone (Lower Mississippian) sandstone, siltstone, and shale.

The soils developed from, or on, drift material of the Late Wisconsin glaciation occupy all the county except the southwestern, the extreme west-central, and extreme southern parts. The parent materials of the greater part of the soils are unconsolidated deposits of mixed silt, clay, sand, gravel, and rock fragments left by the retreating ice sheet. These materials are composed largely of the local underlying bedrock formations over which the glacier advanced, and in this county a large quantity of limestone is included in the drift. A part of the drift, however, includes quartz, granite, schist, gneiss, and other igneous and metamorphic rocks. These do not outcrop in Indiana, and were transported by the glacier from the northern part of the United States and from Canada. The mineralogical and chemical composition of the drift varies somewhat, depending upon the proportion of each constituent.

Thus the soils developed on this heterogeneous mixture under a given drainage condition vary somewhat. As the glacier moved forward, it ground up the bedrock formations over which it moved, mixing the material and either pushing it along in front of it or carrying it within or on top of the ice. The ice sheet rounded off the hills and filled in the valleys. Where it remained rather stationary—when the rate of melting at the ice front equaled the rate of forward movement—the material was deposited as moraines or kames. When the retreat of the ice sheet was rather uniform the material was deposited as ground moraines or gently undulating plains, which characterize the majority of the area of Late Wisconsin glacial drift in this county. Assorted gravel and sand, usually showing cross bedding, was deposited by the interglacial streams and in crevasses on the sides of the glacier.

The rather wide streams that flowed from the melting glacier carried gravel, sand, silt, and clay, and rolled large boulders along where the current was torrential. The coarser gravel was deposited nearer the ice

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[10] BALDWIN, M THE GRAY-BROWN PODZOLIC SOILS OF THE EASTERN UNITED STATES Internatl Cong. Soil Sci Proc and Papers 4 276-282 1928.

front, and the finer materials were carried progressively farther downstream. In some instances large boulders were floated down incased in ice, as icebergs. The distance or length of the glacial streams became longer, as the ice sheet retreated, and sand, silt, and clay were deposited on the gravel and coarser material. This material, deposited by the streams that flowed from the glacier front, comprises the glaciofluvial outwash plains and terraces of Wisconsin Age, which occur as valley terraces along the valley of the White River in the northwestern part of the county, and as outwash plains and terraces along the Blue River and Sugar Creek in the eastern and southeastern parts and to a lesser extent along the valleys of the smaller streams and old glacial drainageways.

The soils developed on drift material of the Early Wisconsin glaciation occur in the southwestern part of the county, usually between areas of Late Wisconsin and Illinoian glacial drift. Their composition and mode of deposition are similar to those of the Late Wisconsin glaciation but because of the greater age and longer exposure to the forces of weathering, lime carbonates are leached to an average depth of about 45 inches.

Soils developed on drift material of the Illinoian glaciation occur in the extreme southwestern part of the county. Their composition and mode of deposition are similar to those of the Early Wisconsin and Late Wisconsin glaciation, but because of the much greater age and longer exposure to the forces of weathering, lime carbonates are leached to a depth of 120 inches of more.

The bedrock formations of Borden or Knobstone sandstone, siltstone, and shale belong to the Lower Mississippian geologic age. They are the surface formations in a small area in the extreme southern part of the county west of Peoga and outcrop along the slopes in the adjacent regions of Illinoian glacial drift.

Wind-deposited sands and silt occur on the east side of the White River. This material was probably blown from the glaciofluvial terraces and the uplands before vegetation had become established.

Calcareous alluvium lies adjacent to the White and Blue Rivers, Sugar Creek, and the tributary streams in regions of Early Wisconsin and Late Wisconsin drift. Strongly acid alluvium occurs adjacent to the small streams and drainageways in the regions of Illinoian drift and Borden sandstone, siltstone, and shale.

The soils of Johnson County are classified and discussed on the basis of their characteristics in three groups—(1) zonal soils; (2) intrazonal soils, and (3) azonal soils. [11]

The zonal soil group, which includes soils having well-developed characteristics that reflect the active factors of soil genesis, climate, and vegetation, is represented in this county by Gray-Brown Podzolic soils.

The Gray-Brown Podzolic soils may be subdivided into three groups—(1) those having an ABC profile, (2) those having an ABYC profile, and (3) those having an AB(X)YC profile. [12]

The first subgroup has a light grayish-brown or brown eluviated A horizon; brown, yellowish-brown, or brownish-yellow illuviated B horizon; and a C horizon composed of physically weathered rock materials that are partly weathered chemically.

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[11] See footnote [8], p 23
[12] See footnote [9], p 23.

The second subgroup has A and B horizons similar to those of the first subgroup, with a thicker B horizon (designated "Y" in the Indiana system of horizon designation) consisting of strongly physically and chemically weathered parent material. The C horizon underlying the Y is similar to that in the normal ABC profile.

The third subgroup has normal A and B horizons, a suggestion of a claypan development (designated "X" in the Indiana system of horizon designation), and a normal C horizon. This group represents a transition from the Gray-Brown Podzolic soils to the Planosols.

The intrazonal soil group, consisting of soils having more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief, parent material, or age over the normal effect of climate and vegetation, includes the Planosols, Semi-Planosols, Wiesenboden and Bog soils.

The Planosols have an ABXYC profile. They have more or less normal A and B horizons, except in the more poorly drained members of the group. Immediately below the B horizon (if present) is a thin light-gray silty horizon varying from a fraction of an inch to a few inches thick, streaks or tongues of which extend downward into the X horizon, or siltpan, immediately beneath. The X horizon, always more or less mottled, has somewhat ill-defined to good columnar structure. The underlying Y horizon, similar to the X horizon, is underlain by the C horizon, which consists of slightly weathered parent material. The X horizon apparently develops best on flat relief where soil-forming processes have been active over a long period of time. An oscillating ground-water table probably contributes also to its formation. Where geologic erosion is encroaching on the old peneplain, lowering the water table and developing a mature relief, there is often a progressive transition from the ABXYC to the ABYC and ABC profiles. Here there is a tendency for the X horizon to be gradually lowered by soil-forming processes, to conform to the slope, and eventually to disappear.

The Semi-Planosols have AB(X)YC, ABYC, or ABC profiles. In the AB(X)YC profile the X (siltpan) horizon is weakly developed and there may be only a slight heaviness in the B horizon.

The Wiesenboden are dark-colored soils of normally poorly drained depressions, classified in the Indiana system of horizon designation as having an HMU profile. The H horizon is very dark brownish-gray to nearly black and high in humus content. It is underlain by the M horizon, which is characterized by a gray to light-gray color in the more poorly drained members of the group represented by the true Wiesenboden, and a mottled gray, yellow, and rust-brown color, the gray predominating in the less poorly drained members represented by the timbered Wiesenboden. The U horizon represents the relatively unmodified underlying mineral material. There is probably a progressive transition from the HMU profile to the AB(X)YC, as drainage and relief change. Few HMU profiles occur in areas of Illinoian glacial drift, an appreciable number occur in the Early Wisconsin glacial drift regions, and they are extensive in areas of Late Wisconsin glacial drift.

Bog soils (DDD profile), developed in depressional areas where water stands continually at or slightly above the surface, consist of a body of plant remains, including sphagnum and other mosses, reeds, grasses, and a smaller proportion of wood.

Azonal soils, those not having well-developed soil characteristics, include the Lithosols and Alluvial soils.

Developed on steep slopes where runoff is rapid and geologic erosion has been sufficiently rapid to counterbalance soil-forming processes, the Lithosols have an AC profile and are relatively thin soils consisting largely of a mixture of rock fragments with a smaller proportion of chemically weathered materials. Eluviation is not pronounced, and there is little evidence of illuviation.

The alluvial soils include recent deposits of material that are, in most cases, subject to additional water deposits; therefore, except in the higher lying areas where there may be a slight development, soil-forming processes have not yet had time to bring about the development of eluviated and illuviated horizons.

A grouping of the soil series by great soil groups, natural drainage conditions, drainage group designation, profile designation, and underlying material are given in table 12.

### GRAY-BROWN PODZOLIC GROUP

The Gray-Brown Podzolic group comprises the well-drained and well to excessively drained soils of the uplands and terraces.

The well-drained soils include the Russell, Miami, Cincinnati, Zanesville, Wellston, and Martinsville.

Russell silt loam, a zonal soil developed on Early Wisconsin glacial drift, has the following profile description in wooded areas:

$A_0$. About ½ inch, accumulated layer of partly decayed leaves, twigs, stems and other forest litter. Reaction, neutral to slightly acid.

$A_1$. 0 to 2 inches, dark brownish-gray or dark-brown mellow grit-free silt loam, relatively high in organic content and containing a mass of fine feeder tree roots. Reaction, medium acid.

$A_2$. 2 to 5 inches, yellowish-brown friable medium-granular grit-free silt loam. The firm but not hard granules can be easily crushed. Numerous small tree roots are present Reaction, medium acid

$A_{2\,2}$ 5 to 9 inches, brownish-yellow or light yellowish-brown medium-granular friable grit-free silt loam, containing many small gray silty worm casts but less roots. The firm but not hard granules may be easily broken down into minute particles when moist. Reaction, medium to strongly acid.

$B_1$. 9 to 14 inches, brownish-yellow or yellowish-brown moderately friable grit-free silty clay loam, breaking into ⅛- to ½-inch subangular aggregates. Small gray silty worm casts are numerous. Reaction, medium to strongly acid.

$B_2$. 14 to 24 inches, yellowish-brown or brownish-yellow silty clay loam, breaking into ¼- to 1-inch subangular aggregates. A few small pebbles, chiefly quartz, are present. Reaction, strongly acid.

$B_{2\,2}$ 24 to 36 inches, brownish-yellow moderately compact silty clay loam, breaking into ¾- to 1¾-inch subangular aggregates. A thin coating of gray colloidal clay on many of the cleavage faces gives a slightly mottled appearance to the material in place. This gray coloration disappears when the material is crushed. Reaction, medium to strongly acid.

$B_3$(Y). 36 to 48 inches, brownish-yellow gritty silty clay loam, breaking into irregular-shaped and variable-sized pieces. Many of the cleavage faces have a thin coating of gray colloidal clay. Reaction, medium acid in the upper part and slightly acid in the lower.

C. 48 inches +, gray and yellow compact calcareous glacial till, consisting of unassorted silt, clay, sand, and rock fragments, which represents the parent soil material.

Miami silt loam, developed on Late Wisconsin glacial drift, differs from Russell silt loam in that the A and B horizons contain more grit and small pebbles, the Y horizon is absent, and the depth to the calcareous C horizon, or parent soil material, is only about 36 inches.

TABLE 12.—*Soil series of Johnson County, Ind, arranged according to great soil groups drainage, profile horizons, and underlying material*

ZONAL SOILS

| Great soil groups [1] and series | Natural drainage conditions [2] | Drainage group designation [3] | Profile designation [4] | Underlying material |
|---|---|---|---|---|
| Gray-Brown Podzolic soils | | | | |
| Bellefontaine | Well to excessively drained | V | ABC | Loose permeable Early Wisconsin and Late Wisconsin drift (calcareous) |
| Cincinnati | Well drained | IV | AB(X)YC | Illinoian drift (calcareous) |
| Fox | Well to excessively drained. | V | ABC | Gravel of Wisconsin age, leached 3 to 5 feet (calcareous) |
| Martinsville | Well drained | IV | ABC | Stratified silt, sand, clay, and some gravel (calcareous) |
| Miami | do | IV | ABC | Late Wisconsin drift (calcareous) |
| Nineveh | Well to excessively drained | V | ABC | Gravel of Wisconsin age, leached 3 to 4 feet (calcareous). |
| Princeton | do | V | AB(Y)C | Wind-deposited sand and silt |
| Russell | Well drained | IV | ABYC | Early Wisconsin drift (calcareous). |
| Wellston | do | IV | ABC | Sandstone, siltstone, and shale or Borden (Knobstone) formation |
| Zanesville | do | IV | AB(X)YC | Do |

INTRAZONAL SOILS

| Great soil groups [1] and series | Natural drainage conditions [2] | Drainage group designation [3] | Profile designation [4] | Underlying material |
|---|---|---|---|---|
| Planosols | | | | |
| Avonburg | Imperfect | II | ABXYC | Illinoian drift (calcareous) |
| Bethel | Poor | I | AB(X)C | Late Wisconsin drift (calcareous) |
| Delmar | do | I | AB(X)YC | Early Wisconsin drift (calcareous) |
| Semi-Planosols | | | | |
| Crosby | Imperfect | II | ABC | Late Wisconsin drift (calcareous). |
| Fincastle | do | II | ABYC | Early Wisconsin drift (calcareous). |
| Gibson | Moderately well drained | III | AB(X)YC | Illinoian drift (calcareous) |
| Homer | Imperfect | II | ABC | Gravel of Wisconsin age, leached 3 to 4 feet (calcareous). |
| Whitaker | do | II | ABC | Stratified silt, sand, clay, and some gravel (calcareous) |
| Wiesenboden (timbered). | | | | |
| Brookston | Very poorly drained | VIII | HMU | Early Wisconsin and Late Wisconsin drift (calcareous) |
| Mahalasville | do | VIII | HMU | Stratified silt, sand, and clay, with some gravel (calcareous) |
| Westland | do | VIII | HMU | Gravel of Wisconsin age (calcareous). |
| Wiesenboden | | | | |
| Abington | do | IX | HMU | Do |
| Clyde | do | IX | HMU | Early Wisconsin and Late Wisconsin drift (calcareous) |
| Bog soils | | | | |
| Carlisle | do | X | DDD | Muck and peat |

AZONAL SOILS

| Great soil groups [1] and series | Natural drainage conditions [2] | Drainage group designation [3] | Profile designation [4] | Underlying material |
|---|---|---|---|---|
| Lithosols | | | | |
| Muskingum | Well to excessively drained | VI | AC | Sandstone, siltstone, and shale of Borden (Knobstone) formation |
| Alluvial soils | | | | |
| Eel | Moderate to imperfect | III | DDD | Neutral to slightly alkaline alluvium from Wisconsin drift |
| Genesee | Well drained | IV | DDD | Do |
| Philo | Moderately well drained | III | DDD | Strongly acid mixed alluvium from Borden sandstone, siltstone, and shale and Illinoian drift |
| Pope | Well drained | IV | DDD | Do |
| Ross | do | IV | DDD | Neutral to slightly alkaline alluvium from Wisconsin drift |

[1] Grouping based on soil classification defined in Soils and Men, Yearbook of Agriculture, 1938

[2] Natural drainage conditions refer to drainage conditions existing before improvements Most areas of soil classified as having imperfect, poor, and very poor drainage conditions have been artificially drained sufficiently to permit cultivation

[3] Based on data from The Story of Indiana Soils, Spec Cir. No 1, by T M Bushnell, associate in agronomy, Department of Agronomy, Purdue University Agricultural Experiment Station. Group I includes nearly level poorly drained soils without organic accumulation and with eluviated and illuviated horizons; group II, nearly level to gently undulating imperfectly drained soils, with mottling in the lower A horizon, group III, nearly level to gently sloping moderately well-drained soils, with mottling in the $B_1$ or $B_2$ horizons, group IV, undulating to steeply sloping well-drained soils, group V, level to rolling well to excessively drained soils, characterized by loose porous substratum of gravel or sand; group VI, sloping to steep well to excessively drained soils in which geologic erosion has prevented soil development; groups VIII and IX, very poorly drained depressional soils with an accumulation of organic matter in the surface horizon; and group X, very poorly drained organic soils, representing an accumulation of peat and muck

[4] Based on Indiana system of horizon designation; the X horizon includes the siltpan or claypan and is a part of the B horizon, the Y horizon includes the lower B horizon that is silty in character, the H horizon designates the humus or organic-bearing horizons in the VIII and IX drainage profiles and the organic horizons in the X profile, the M horizon is the modified mineral subsoil below the H horizon, the U horizon is the unmodified geologic deposits below the M horizon and the D horizons refer to various depositional layers in alluvium.

Cincinnati silt loam, developed on Illinoian glacial drift, differs from Russell silt loam in color and number of horizons and the depth and degree of leaching of bases. The A and B horizons are strongly acid and silty. A weakly developed siltpan, or X horizon, is present at a depth of about 36 inches in some areas. The Y horizon, representing the material between the main B and C horizons, is brownish-yellow silty material in the upper part and mottled gray and yellow in the lower. The calcareous C horizon, or parent soil material, lies at a depth of 120 to 150 inches.

Zanesville silt loam, occurring on the broader or rounded ridge tops, is developed on Borden sandstone, siltstone, and shale. The A and upper B horizons are similar to those of Cincinnati silt loam, but a siltpan, or X horizon, is developed at a depth of 30 to 36 inches and underlain by the silty Y, or lower B horizon. Bedrock of sandstone, siltstone, and shale occurs at a depth of 5 or 6 feet.

Wellston silt loam, developed on Borden sandstone, siltstone, and shale on narrow ridge tops, has a light yellowish-brown friable silt loam A horizon underlain by a well-oxidized yellowish-brown B horizon. Bedrock of sandstone, siltstone, and shale lies at a depth of about 30 inches.

Developed on glaciofluvial outwash plains and terraces consisting of calcareous stratified silt and sand, with small quantities of clay and gravel of Wisconsin age, the Martinsville soils have light yellowish-brown A horizons and yellowish-brown or weak reddish-brown B horizons and are leached of free calcium carbonates to a depth of about 40 inches.

The well to excessively drained soils of the Gray-Brown Podzolic group are the Fox, Nineveh, Bellefontaine, and Princeton.

The Fox soils are developed on glaciofluvial outwash plains and terraces of Wisconsin age. The following profile description of Fox loam, taken in a cultivated field, is representative.

$A_1$. 0 to 7 inches, light yellowish-brown friable medium-granular loam, relatively low in organic content. The firm but not hard granules may be easily pulverized when moist. This horizon represents the plow soil. Reaction, medium acid.

$A_2$. 7 to 11 inches, light yellowish-brown friable coarse-granular heavy loam, containing a few small light-gray to gray silty worm casts. Reaction, medium acid.

$B_1$. 11 to 16 inches, yellowish-brown gritty clay loam, breaking into ¼- to ½-inch subangular aggregates. It is moderately sticky when wet and hard when dry. Numerous particles of small rounded glacial gravel are present. Reaction, medium acid.

$B_2$. 16 to 32 inches, yellowish-brown or weak reddish-brown waxy and gravelly clay loam, breaking into angular pieces, sticky when wet, plastic when moist, and hard when dry. It contains numerous small rounded glacial gravel and an occasional large boulder. Reaction, medium acid.

$B_3$. 32 to 36 inches, dark-brown to dark yellowish-brown waxy and gravelly clay loam, breaking into irregular pieces. There is an abrupt change from the above horizon to this material and from this to the underlying material. Tongues or lenses of this horizon extend into the underlying material. Reaction, neutral.

C. 36 inches +, gray and yellow loose stratified calcareous gravel and sand.

Nineveh loam is similar to Fox loam in profile characteristics, with the exception of a relatively high organic content in the surface 10 inches and the neutral or only slightly acid A and B horizons.

Bellefontaine loam occupies morainic and kame areas in the Wisconsin glacial drift regions. Its profile is similar to that of the Fox soils but less uniform in horizon development, and the loose gravel and sand

of the C layer is usually cross-bedded rather than horizontally bedded. The profile associated with Early Wisconsin glacial drift is somewhat more acid than that associated with Late Wisconsin glacial drift.

Princeton fine sandy loam, developed on wind-deposited sands, occurs principally along the bluffs of the valley of the White River. Profile development has produced ABYC horizons. The clay accumulation in the B horizon is variable and is underlain by rather loose fine sand, representing the Y horizon. The C horizon of gray and yellow calcareous fine sand to sand lies at an average depth of about 60 inches.

### PLANOSOLS

The Planosol group includes imperfectly drained and poorly drained soils.

Avonburg silt loam, the imperfectly drained Planosol in this county, occurs on nearly level interstream areas in the Illinoian glacial drift region. Following is a profile description typical of this soil under a forest vegetation:

- $A_0$. About ½-inch accumulated layer of partly decayed leaves, twigs, stems, and other forest litter
- $A_1$. 0 to 2 inches, dark-gray or dark brownish-gray friable silt loam, relatively high in organic content and composed of soft, fine to medium granules. Reaction, strongly acid.
- $A_2$. 2 to 7 inches, light brownish-gray to brownish-gray grit-free friable medium-granular silt loam, containing numerous crayfish casts and old root channels of gray silty material that extend into the lower horizon. Reaction, strongly acid
- $A_{2\,2}$. 7 to 10 inches, light brownish-gray to brownish-gray grit-free coarse-granular heavy silt loam to silty clay loam, with an occasional faint light-yellow mottling. Reaction, strongly acid.
- $B_1$. 10 to 16 inches, mottled gray, yellow, and rust-brown grit-free silty clay loam breaking into ¼- to ½-inch subangular aggregates. Reaction, strongly acid.
- $B_2$. 16 to 30 inches, mottled gray, yellow, and rust-brown grit-free silty clay loam breaking into ½- to 1½-inch subangular aggregates. The material is slightly compact in place, but when moist may be easily broken down into coarse granules. Reaction, strongly acid.
- $B_{22}(X_1)$. 30 to 32 inches, light-gray, with light-yellow mottlings, friable silt loam to silty clay loam, which represents the caps of the vertical columns of the horizon below. Reaction, strongly acid.
- $B_{23}(X_2)$. 32 to 50 inches, mottled gray, yellow, and rust-brown heavy compact silty clay loam, which breaks into vertical columns having a horizontal dimension of 1½ to 3 inches and a vertical dimension of 6 to 8 inches or more There is usually a thin coating of gray colloidal clay on the cleavage faces. Reaction, strongly acid.
- $B_3(Y)$. 50 to 120 inches, mottled gray, yellow, and rust-brown somewhat friable silty clay loam, breaking into subangular irregular-sized pieces that are easily broken down into coarse granules. Small quantities of grit, sand, and rock fragments are present in the upper part and increase with depth Reaction, strongly acid in the upper part and slightly acid in the lower.
- C. 120 inches +, gray and yellow compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments. This represents the parent soil material.

With the exception of the texture of the surface horizon, variations from the above profile description occur in texture and thickness of the various horizons and in depth to calcareous till.

The poorly drained Planosols are the Delmar and Bethel silt loams.

Delmar silt loam occurs on nearly level relief and is developed on Early Wisconsin glacial till. The following profile description is representative of this soil under a forest cover:

$A_0$. ¼- to ½-inch accumulated layer of partly decomposed forest litter.

$A_1$. 0 to 3 inches, dark brownish-gray grit-free fine-granular silt loam, with a relatively high organic content. Reaction, neutral or slightly acid.

$A_2$. 3 to 10 inches, light-gray to gray grit-free friable silt loam, with a few rust-brown or light-yellow mottlings or streaks and numerous rust-brown small rounded iron concretions. Reaction, medium acid.

$B_1$. 10 to 16 inches, light-gray to gray silty clay loam, with numerous rust-brown spots or blotches and small rounded iron concretions. The material breaks into ¼-inch subangular aggregates. Reaction, strongly acid.

$B_2$. 16 to 32 inches, mottled gray, yellow, and rust-brown silty clay loam, breaking into ½- to 2-inch subangular aggregates. The upper part of this horizon is grit-free, but the lower part is somewhat gritty and contains a few small pebbles. Reaction, strongly acid.

$B_3$(Y). 32 to 45 inches, mottled gray, yellow, and rust-brown gritty silty clay loam, containing numerous small pebbles and an occasional boulder. It breaks into subangular irregular-sized pieces and is more friable than the above horizon. Reaction, medium acid.

C. 45 inches +, gray and yellow compact calcareous glacial till, composed of unassorted silt, clay, sand, and rock fragments, representing the parent soil material.

Bethel silt loam, developed on glacial drift of Late Wisconsin age, differs from Delmar silt loam in having a gritty B horizon in the absence of a Y horizon and in the occurrence of calcareous till at a depth of 28 to 36 inches.

### SEMI-PLANOSOLS

The semi-Planosol group includes moderately well-drained and imperfectly drained soils of the county.

Gibson silt loam, the moderately well-drained semi-Planosol occurring on nearly level to undulating relief, is developed on Illinoian glacial drift. The A horizons are similar to those of Cincinnati silt loam, except that the color of the lower A horizon is usually light brownish yellow. The light brownish yellow to pale yellow silt loam to silty clay loam $B_1$ horizon becomes mottled gray, yellow, and rust brown in the extreme lower part or in the $B_2$ horizon. The X horizon, usually only 6 to 12 inches thick and generally occurring at a depth of about 30 inches, is similar in texture and structure to the horizon of Avonburg silt loam. The more friable Y horizon contains some grit and pebbles and is underlain by calcareous glacial till, representing the C horizon, at a depth of 120 to 150 inches.

The imperfectly drained soils of the semi-Planosol group are the Fincastle, Crosby, Homer, and Whitaker.

The Fincastle soil, developed on glacial drift of the Early Wisconsin age, has an ABYC horizon and has been leached of free-lime carbonates to a depth of about 45 to 48 inches. The A and upper B horizons are smooth and free of coarse-textured material. The B horizon with a slight siltpan development is somewhat compact and impervious to moisture movement. The Y, or lower B horizon is friable gritty material, and the C horizon consists of unassorted calcareous till composed of silt, clay, sand, and rock fragments.

Crosby silt loam, having a nearly level to undulating relief, is developed on Late Wisconsin glacial drift. It has an ABC profile, and has been leached of free-lime carbonates to a depth of about 36 inches. The A and B horizons are not so silty or so acid as those of Fincastle silt loam, the Y, or lower B horizon is absent and the calcareous C horizon consists of unassorted calcareous till composed of silt, clay, sand, and rock fragments.

Homer silt loam, occurring on glaciofluvial outwash plains and terraces, is developed on stratified gravel and sand of the Wisconsin glacial period, and free-lime carbonates occur at a depth of 36 to 45 inches. Except for a larger content of grit and pebbles and the usually waxy and gravelly clay loam $B_2$ horizon, the A and B horizons are similar to those of Crosby silt loam. The lower B, or $B_3$ horizon is variable in thickness —averaging about 5 inches—and slightly darker colored than the upper B horizon. The C horizon consists of calcareous stratified gravel and sand, which usually shows horizontal stratification.

The Whitaker soils have developed on stratified silt and sand, with small quantities of clay and gravel, of the Wisconsin glacial period, and have been leached of free-lime carbonates to a depth of 40 to 50 inches. The profile is similar to that of the Fincastle soil, except that the A and B horizons contain more grit and pebbles and the C horizon consists of calcareous stratified silt and sand with small quantities of clay and gravel.

## WIESENBODEN GROUP

The Wiesenboden group includes soils now timbered and those having a grass vegetation.

The timbered Wiesenboden group includes the Brookston, Mahalasville, and Westland silty clay loams.

Brookston silty clay loam occupies slight depressions and broad flats in the regions of Early Wisconsin and Late Wisconsin drift. Following is a description of a typical profile of this type in wooded areas:

1($H_1$) ¼- to ½-inch accumulated layer of leaves, twigs, and other forest litter.
2($H_2$). 0 to ½ inch, very dark-gray fine-granular silt loam, containing a very high proportion of organic matter and numerous small feeder tree roots. Reaction, neutral.
3($H_3$). ½ to 5 inches, dark-gray or very dark brownish-gray coarse-granular silty clay loam, relatively high in organic content and containing numerous fine tree roots. Reaction, neutral
4($H_4$) 5 to 14 inches, dark brownish-gray heavy silty clay loam or clay loam, breaking into ⅛- to ¾-inch angular pieces. Numerous small pebbles and an occasional boulder are present. Reaction, neutral.
5($M_1$). 14 to 21 inches, mottled gray, yellow, and rust-brown plastic silty clay to sandy clay, breaking into ½- to 2½-inch angular pieces and containing much grit, numerous pebbles, and an occasional boulder. The material is sticky when moist and hard when dry Reaction, neutral.
6($M_2$). 21 to 60 inches, intensively mottled gray and yellow plastic silty clay to sandy clay, breaking into 1- to 6-inch irregular-angular pieces and containing numerous pebbles and rock fragments. The mottling often occurs in pockets or as blotches, and there is an occasional pocket of lighter textured material. Reaction, neutral.
7(U). 60 inches +, gray and yellow compact calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

Mahalasville silty clay loam, occurring usually in slight depressions or rather broad flats on glaciofluvial outwash plains and terraces, is developed on stratified silt and sand, with some clay and gravel. The profile characteristics are similar to those of Brookston silty clay loam, except that rock fragments and larger stones are absent in the subsoil and that it is underlain by stratified silt and sand with some calcareous clay and gravel at a depth of 40 to 60 inches.

Westland silty clay loam, occurring on glaciofluvial outwash plains and terraces usually in association with the Fox and Homer soils, is developed on calcareous stratified gravel and sand. The subsoil, or M horizons, is usually waxy and gravelly clay loam containing more grit.

rounded pebbles, and gravel than that of Mahalasville silty clay loam. The U horizon, or underlying material, is calcareous stratified gravel and sand that usually shows horizontal bedding.

The true Wiesenboden group includes the Abington and Clyde silty clay loams.

Abington silty clay loam occupies the deeper depressional areas of the glaciofluvial outwash plains and terraces. The H horizons are higher in organic content and thicker than those in the Mahalasville and Westland soils. The upper M, or glei, horizon is gray waxy and gravelly material and the lower M horizon is usually highly mottled. The U horizon, or underlying material, occurring at a depth of 45 to 70 inches, consists of loose calcareous stratified gravel and sand, with some silt and clay.

Clyde silty clay loam occupies the depressional areas in the region of Wisconsin glaciation. The H horizons are higher in organic content and thicker than those in the associated Brookston soils; the upper M horizon is gray; the lower M horizons are highly mottled gray, yellow, and rust brown; and the U horizon, or underlying material, consists of unassorted calcareous glacial till.

## BOG SOILS

Carlisle silty muck, representing the Bog soils in this county, covers the deepest depressional areas, principally in the regions of Late Wisconsin glaciation. It consists of an accumulation of plant remains, including sphagnum and other mosses, reeds, sedges, and some wood, and the surface 6 to 10 inches contains considerable silty mineral material.

## LITHOSOLS

The Lithosols are represented by Muskingum stony silt loam, which occurs on hilly and steep relief on sandstone, siltstone, and shale of the Borden formation. Runoff is so rapid that the soil lacks moisture for normal vegetation and soil formation. The light yellowish-brown to yellowish-gray silty A horizon grades into the C horizon of sandstone, siltstone, and shale at depths of 12 to 25 inches, with very little or no B horizon development. Numerous rock fragments are on the surface and throughout the profile.

## ALLUVIAL SOILS

The Alluvial soils are divided into two groups, (1) neutral to slightly alkaline alluvium and (2) strongly acid alluvium.

Soils occurring on neutral to slightly alkaline alluvium washed from areas of Early Wisconsin and Late Wisconsin glacial drift and from glaciofluvial outwash plains and terraces are the Genesee, Ross, and Eel. The Genesee and Ross soils are well drained and Eel soils moderately well drained to imperfectly drained.

Pope and Philo silt loams occur on strongly acid alluvium washed from regions of Illinoian glacial drift and Borden sandstone, siltstone, and shale. The former is well drained and the latter moderately well drained.

The soils of Johnson County may be grouped into catenas. This term was first used by Milne. [13] The catena is composed of soil series developed on similar parent material under similar climatic conditions,

[13] MILNE, G. PROVISIONAL SOIL MAP OF EAST AFRICA. 34 pp., illus. London, 1936.

but having differences in profile characteristics corresponding to differences in natural drainage conditions. For example, members of the Miami, Crosby, Bethel, Brookston, and Clyde series comprise a catena of soils developed on calcareous till of the Late Wisconsin glaciation. Differences in the profile characteristic of these soils are due very largely to differences in drainage conditions and relief and their attendant effects. The concept of the catena is very useful and convenient for field identification and mapping of soils and for considering their geographic and geologic relations.

## MANAGEMENT OF THE SOILS

By A. T. WIANCKO, Department of Agronomy, Purdue University Agricultural Experiment Station

The farmer should know his soil and have a sound basis for every step in its treatment. Building up the productivity of a soil to a high level, in a profitable way, and then keeping it up is an achievement toward which the successful farmer strives. As in any other enterprise, every process must be understood and regulated in order to be uniformly successful, and a knowledge of the soil is highly important. Different soils present different problems as to treatment, and these must be studied and understood in order that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory unless it produces profitable returns. Some soil treatments and methods of management may be profitable for a time but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in the United States. A proper system of treatment is necessary in making a soil profitably productive.

Table 13 shows the approximate total content of nitrogen, phosphorus, and potassium in the principal types of soil in Johnson County, expressed in pounds of elements in 2,000,000 pounds an acre of 6- to 7-inch plowed surface soil and the relative quantities of available phosphorus and potassium.

The total contents of nitrogen, phosphorus, and potassium for the various soils, as given in table 13, do not necessarily represent the results obtained from samples taken within the county. A number of the totals represent an average for the soil type in the State.

The total content of nitrogen in a soil is generally indicative of the need for nitrogen. It generally indicates also the need for organic matter because nitrogen and organic matter are closely associated in soils. Usually, the darker the soil the higher its content of both organic matter and nitrogen. Soils having a low total nitrogen content soon wear out, as far as that element is concerned, unless the supply is replenished by the growing and turning under of legumes, or by the use of nitrogenous fertilizer.

The quantity of phosphorus in most soils is usually about the same as that shown by a determination with strong acid. For this reason, a separate determination of total phosphorus has been omitted. The supply of total phosphorus is low in most Indiana soils and phosphatic fertilizers are generally needed.

**TABLE 13.**—*Approximate quantities of nitrogen, phosphorus, and potassium in certain soils of Johnson County, Ind.*

[Elements in pounds per acre of surface soil, 6 to 7 inches deep]

| Soil | Total nitrogen | Total phosphorus[1] | Total potassium | Available phosphorus[2] | Available potassium[2] |
|---|---|---|---|---|---|
| | *Pounds* | *Pounds* | *Pounds* | | |
| Abington silty clay loam | 4,800 | 1,400 | 28,000 | H | H |
| Avonburg silt loam | 2,400 | 550 | 25,000 | VL | L |
| Bellefontaine loam | 2,200 | 610 | 37,000 | L | M |
| Bethel silt loam | 2,400 | 440 | 30,000 | VL | L |
| Brookston silty clay loam | 4,200 | 1,000 | 32,000 | M | M |
| Cincinnati silt loam | 2,200 | 450 | 31,000 | VL | M |
| Clyde silty clay loam | 4,800 | 1,310 | 31,000 | H | H |
| Crosby silt loam | 2,600 | 610 | 28,000 | L | L |
| Delmar silt loam | 2,200 | 520 | 28,000 | VL | L |
| Eel silt loam | 3,000 | 940 | 27,000 | M | M |
| Eel silty clay loam | 3,400 | 1,270 | 32,000 | H | H |
| Fincastle silt loam | 2,200 | 520 | 29,000 | VL | M |
| Fox loam | 1,600 | 520 | 24,000 | L | M |
| Fox silt loam | 2,800 | 740 | 26,000 | L | H |
| Genesee fine sandy loam | 1,000 | 720 | 21,000 | M | L |
| Genesee loam | 2,200 | 810 | 28,000 | M | M |
| Genesee silt loam | 3,000 | 1,020 | 25,000 | H | M |
| Gibson silt loam | 2,000 | 520 | 28,000 | VL | M |
| Homer silt loam | 2,200 | 610 | 26,000 | L | M |
| Mahalasville silty clay loam | 4,000 | 1,220 | 29,000 | H | H |
| Martinsville loam | 2,400 | 640 | 27,000 | L | M |
| Martinsville silt loam | 2,400 | 700 | 26,000 | M | M |
| Miami loam | 2,000 | 520 | 26,000 | L | M |
| Miami silt loam | 2,400 | 520 | 31,000 | VL | M |
| Nineveh loam | 2,400 | 1,220 | 25,000 | H | L |
| Philo silt loam | 2,400 | 620 | 30,000 | VL | M |
| Pope silt loam | 2,400 | 620 | 29,000 | VL | M |
| Princeton fine sandy loam | 1,600 | 440 | 24,000 | L | M |
| Ross silty clay loam | 4,000 | 1,440 | 31,000 | H | H |
| Russell silt loam | 2,400 | 650 | 31,000 | L | M |
| Westland silty clay loam | 4,400 | 1,050 | 29,000 | M | M |
| Whitaker loam | 2,200 | 440 | 25,000 | VL | M |
| Whitaker silt loam | 2,400 | 610 | 26,000 | L | M |
| Zanesville silt loam | 2,200 | 500 | 30,000 | VL | M |

[1] Soluble in strong hydrochloric acid (specific gravity 1.115).
[2] VL=very low, L=low, M=medium, and H=high.

The total quantity of potassium in the soil can seldom be taken as indicative of whether or not it needs potash fertilizer. Some Indiana soils that have more than 30,000 pounds of total potassium an acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization because so little of the potassium they contain is in an available form. Sandy soils and muck soils are more often in need of potash fertilization than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need potash fertilization more than well-aerated deep soils.

The available phosphorus and potassium determinations have been made by means of the so-called quick tests and are expressed in terms indicating relative quantities, as very low, low, medium, high, and very high. In interpreting these terms it may usually be assumed that soils testing low or very low will respond to fertilization with the element concerned. If the soil tests medium there may be doubt as to whether or not fertilization would pay. A soil testing high or very high would seem to be in no immediate need of application of the plant food element concerned. Since the quick test is easily made, it is recommended that the soil or soils of each field of the farm be tested every few years because the available supply of any particular element may change, owing to the cropping system, the quantities of crops removed, manure returned, and fertilizer added. Plant tissue tests at critical periods in the

development of the crop will show its nutrient status and which elements are lowest in supply and most in need of replenishing. It should be emphasized, however, that the results or values obtained by quick tests vary greatly from year to year, depending on soil management and seasonal conditions.

In considering what has been said in the preceding pages about the total and available supplies of plant nutrients in the soils, it should be recognized that there are many other factors that affect the crop-producing powers of soils. These chemical data, therefore, are not intended to be the sole guide in determining the needs of the soil. The depth and physical character of each of the horizons of the soil profile and the previous treatment and mangement of the soil are factors of great importance to be taken into consideration. Tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than in surface soils. On the other hand, potash in the subsoil seems to be of relatively high availability. Crop growth depends largely on the quantity of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth on a soil of relatively low analysis; if the roots are shallow, the crop may suffer from lack of nutrients, particularly potash, even on a soil of higher analysis. The better types of soils and those containing large quantities of plant nutrients will endure exhaustive cropping much longer than the soils of low nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity. Soils that are very acid will not produce well, even though there is no lack of plant nutrients, because solubilities of the various nutrients change and the nutritional balance is upset. For example, although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect until after such soils are limed.

Table 14 shows the percentage of nitrogen and the acidity of the principal soils of Johnson County and the estimated lime requirement.

The acidity is expressed as pH, or approximate hydrogen-ion concentration. For example, pH 6.6 to 7.3 is neutral, and a soil with a pH value in this range contains just enough lime to neutralize the acidity. Soils testing between pH 6.6 and 6.1 are called slightly acid; between 6.0 and 5.6, medium acid; between 5.5 and 5.1, strongly acid; and below 5.0, very strongly acid. As a rule, the lower the pH value the more the soil needs lime. Samples were taken from the surface soil (0 to 6 inches), from the subsurface soil, and from the subsoil. It is important to know the reaction, not only of the surface soil but also of the lower layers of the soil. Given two soils of the same acidity in the surface horizon, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The slighter the depth of acid soil, the less likely it is to need lime. Those soils having a greater clay content will need a greater quantity of lime to neutralize them, given the same degree of acidity. The less phosphorus, calcium, and magnesium the soil contains, the more likely it is to need lime. It is well to remember that sweetclover, alfalfa, and red clover need lime more than do other crops. As it is advisable to grow these better soil-improving legumes in the crop rotation, soils that are acid should be limed.

In interpreting the soil survey map and soil analyses, it should be borne in mind that a well-farmed and well-fertilized soil that is naturally

low in fertility may produce larger crops than a poorly farmed soil naturally higher in fertility.

For convenience in discussing the management of the several soils of this county, they are arranged in groups according to certain important characteristics, which indicate that in some respects similar treatment is required. The intensity of the treatments, however, varies considerably in the different soil types. For example, several of the light-colored silt loams of the uplands and terraces, which have practically the same requirements for their improvement, may be conveniently discussed as a group, thus avoiding the repetition that would be necessary if each were discussed separately. It should be remembered, however, that relief, acidity, reaction, character of the subsoil and substrata, and other characteristics of a soil type within the group may be and frequently are sufficiently different to require various recommendations and treatment. This includes quantity of limestone required, quantity and analysis of commercial fertilizers needed, and the feasibility of attempting to grow certain crops. The reader should study the group that includes the soils in which he is particularly interested.

About 35.1 percent of the soils is on uplands and terraces having undulating to steep relief, and about 2 percent of this area is nonarable; 54.3 percent, occurring on flat or depressed to gently undulating relief, is naturally imperfectly or poorly drained, and slightly less than a half of this is dark-colored; and 10.6 percent is alluvial or first-bottom soils. There are only 384 acres of sandy soil in the entire county.

## IMPERFECTLY AND POORLY DRAINED LIGHT-COLORED SOILS OF THE UPLANDS AND TERRACES

The group of imperfectly and poorly drained light-colored soils of the uplands and terraces includes Crosby, Bethel, Fincastle, Delmar, Avonburg, Homer, and Whitaker silt loams and Whitaker loam. These soils occupy 58,560 acres, or 28.4 percent of the total area of the county, Crosby silt loam occupying 26.1 percent.

These soils, although some of them differ considerably because of differences in parent material and depth of leaching, have important characteristics in common, in respect to which their management problems are similar. All are more or less in need of artificial drainage, although the Bethel and Delmar are naturally more poorly drained. All are low in total content of organic matter, nitrogen, and phosphorus; most of them are low to very low in available phosphorus and low to medium in available potassium; and all are more or less in need of liming. The quantity of lime required, the quantity and analysis of fertilizers needed, as well as crop adaptation, however, varies considerably with the different soil types.

### DRAINAGE

All the imperfectly and poorly drained light-colored soils of the uplands and terraces were developed under conditions of imperfect to poor drainage. Their flat to gently undulating topography, together with rather heavy subsoil, makes them naturally wet and more or less seriously in need of artificial drainage. Surface drainage by means of dead furrows and open ditches is more or less practical but wasteful of fertility in surface runoff. Tile underdrainage is much more desirable, and where not already provided should have early attention in any permanent soil improvement program. Without tile drainage, these soils cannot be

TABLE 14.—*Percentage of nitrogen and acidity in certain soils of Johnson County, Ind*

| Soil | Depth | Nitrogen | pH | Average depth to neutral material | Indicated ground limestone requirement per acre |
|---|---|---|---|---|---|
| | *Inches* | *Percent* | | *Inches* | *Tons* |
| Abington silty clay loam | 0- 6 | 0 24 | 7 1 | 0 | 0 |
| | 6-18 | 14 | 7 2 | | |
| | 18-36 | .04 | 7 2 | | |
| Avonburg silt loam | 0- 6 | .12 | 5.2 | 120 | 3-5 |
| | 6-18 | .07 | 4 9 | | |
| | 18-36 | .04 | 4 8 | | |
| Bellefontaine loam | 0- 6 | .11 | 6 4 | 38 | 1-2 |
| | 6-18 | 07 | 6 3 | | |
| | 18-36 | .04 | 6.8 | | |
| Bethel silt loam | 0- 6 | 12 | 6 5 | 32 | 1-2 |
| | 6-18 | 06 | 5 8 | | |
| | 18-36 | .04 | 7 0 | | |
| Brookston silty clay loam | 0- 6 | 21 | 7 1 | 0 | 0 |
| | 6-18 | 08 | 7 0 | | |
| | 18-36 | 03 | 7 1 | | |
| Cincinnati silt loam | 0- 6 | 11 | 5.6 | 120 | 3-4 |
| | 6-18 | 04 | 5 2 | | |
| | 18-36 | 02 | 5 0 | | |
| Clyde silty clay loam | 0- 6 | 24 | 7 1 | 0 | 0 |
| | 6-18 | .18 | 7 2 | | |
| | 18-36 | .05 | 7 2 | | |
| Crosby silt loam | 0- 6 | .13 | 6 3 | 32 | 1-2 |
| | 6-18 | .05 | 5 9 | | |
| | 18-36 | .04 | (1) | | |
| Delmar silt loam | 0- 6 | 11 | 5 5 | 42 | 1-3 |
| | 6-18 | 06 | 5.2 | | |
| | 18-36 | .04 | 5 4 | | |
| Eel silty clay loam | 0- 6 | .17 | 7 2 | 0 | 0 |
| | 6-18 | 13 | 7.2 | | |
| | 18-36 | .09 | 7 2 | | |
| Eel silt loam | 0- 6 | .15 | 7 0 | 0 | 0 |
| | 6-18 | .08 | 7 1 | | |
| | 18-36 | .04 | 7 2 | | |
| Fincastle silt loam | 0- 6 | .11 | 5 7 | 42 | 1-3 |
| | 6-18 | 07 | 5 4 | | |
| | 18-36 | 05 | 5 9 | | |
| Fox loam | 0- 6 | .08 | 6 0 | 40 | 1-2 |
| | 6-18 | .05 | 6.0 | | |
| | 18-36 | 04 | 6 1 | | |
| Fox silt loam | 0- 6 | 14 | 6 2 | 40 | 1-2 |
| | 6-18 | 10 | 5 5 | | |
| | 18-36 | 07 | 6 0 | | |
| Genesee fine sandy loam | 0- 6 | 08 | 7 2 | 0 | 0 |
| | 6-18 | 05 | 7 2 | | |
| | 18-36 | 05 | 7.2 | | |
| Genesee loam | 0- 6 | 11 | 7 2 | 0 | 0 |
| | 6-18 | .08 | 7 3 | | |
| | 18-36 | 04 | 7 3 | | |
| Genesee silt loam | 0- 6 | 15 | 7 1 | 0 | 0 |
| | 6-18 | .05 | 7 2 | | |
| | 18-36 | .04 | 7 2 | | |
| Gibson silt loam | 0- 6 | 10 | 5.4 | 120 | 3-4 |
| | 6-18 | 06 | 5 2 | | |
| | 18-36 | .02 | 4.9 | | |
| Homer silt loam | 0- 6 | .11 | 6 0 | 42 | 1-2 |
| | 6-18 | .09 | 5 5 | | |
| | 18-36 | 06 | 5.6 | | |
| Mahalasville silty clay loam | 0- 6 | 23 | 6.9 | 0 | 0 |
| | 6-18 | .10 | 6 8 | | |
| | 18-36 | 07 | 7 2 | | |
| Martinsville loam | 0- 6 | .12 | 6 6 | 50 | 1-2 |
| | 6-18 | 07 | 5 4 | | |
| | 18-36 | 04 | 5 5 | | |
| Martinsville silt loam | 0- 6 | 12 | 6 2 | 45 | 1-2 |
| | 6-18 | 09 | 5.7 | | |
| | 18-36 | 07 | 5 4 | | |
| Miami loam | 0- 6 | .10 | 6 4 | 32 | 1-2 |
| | 6-18 | 07 | 5 6 | | |
| | 18-36 | 04 | 6.5 | | |
| Miami silt loam | 0- 6 | 12 | 6 4 | 32 | 1-2 |
| | 6-18 | 07 | 6 0 | | |
| | 18-36 | 05 | (1) | | |
| Nineveh loam | 0- 6 | 12 | 6 8 | 0 | 0 |
| | 6-18 | .06 | 7 0 | | |
| | 18-36 | 05 | 7 0 | | |

See footnotes at end of table

TABLE 14.—*Percentage of nitrogen and acidity in certain soils of Johnson County, Ind.*—Continued

| Soil | Depth | Nitrogen | pH | Average depth to neutral material | Indicated ground limestone requirement per acre |
|---|---|---|---|---|---|
| | *Inches* | *Percent* | | *Inches* | *Tons* |
| | 0–6 | .12 | 5.7 | | |
| Philo silt loam | 6–18 | .11 | 5.4 | (2) | 2-3 |
| | 18–36 | .08 | 5.6 | | |
| | 0–6 | .12 | 5.4 | | |
| Pope silt loam | 6–18 | .11 | 5.5 | (2) | 2-3 |
| | 18–36 | .08 | 5.6 | | |
| | 0–6 | 08 | 6.4 | | |
| Princeton fine sandy loam | 6–18 | 05 | 6.5 | 60 | 1-3 |
| | 18–36 | .02 | 6.8 | | |
| | 0–6 | 20 | 6.9 | | |
| Ross silt clay loam | 6–18 | .16 | 7.0 | 0 | 0 |
| | 18–36 | .10 | 7.1 | | |
| | 0–6 | .12 | 6.0 | | |
| Russell silt loam | 6–18 | .06 | 5.2 | 42 | 1-3 |
| | 18–36 | .04 | 5.6 | | |
| | 0–6 | .22 | 7.1 | | |
| Westland silty clay loam | 6–18 | .10 | 7 2 | 0 | 0 |
| | 18–36 | .08 | 7.3 | | |
| | 0–6 | 11 | 6.4 | | |
| Whitaker loam | 6–18 | .05 | 5.5 | 50 | 0-2 |
| | 18–36 | .02 | 5.8 | | |
| | 0–6 | .12 | 6.9 | | |
| Whitaker silt loam | 6–18 | .04 | 5.5 | 50 | 0-2 |
| | 18–36 | .04 | 5.6 | | |
| | 0–6 | .11 | 5.5 | | |
| Zanesville silt loam | 6–18 | .08 | 5.1 | (3) | 3-4 |
| | 18–36 | 05 | 4.9 | | |

[1] Calcareous at a depth of about 36 inches.
[2] Acid to a depth of several feet.
[3] Acid to bedrock.

managed to the best advantage and no other beneficial soil treatment can produce its full effect.

With reasonable provision for drainage, these soils respond well to lime, manure, and fertilizer and can be made profitably productive. This has been fully demonstrated on the soil-fertility experiment fields conducted by the Purdue University Agricultural Experiment Station on comparable soils in other parts of the State. The results on these fields indicate that tile lines laid 30 to 40 inches deep and 3 to 4 rods apart will give satisfactory results. The Homer and Whitaker soils are underlain by stratified gravel and sand and silt and sand, respectively, and tile lines do not need to be so close as given above.

Where the land is flat, care must be exercised in tiling in order to obtain an even grade and uniform fall. Unsatisfactory results in tiling these flat lands are traceable to errors in grades, which allow silting up in low spots, and to poor-quality tile which chips and breaks down easily. Only the best quality of tile should be used. Grade lines should not be established by guess or by rule-of-thumb methods. Nothing less accurate than a surveyor's instrument should be used and the lines accurately staked and graded before ditches are dug, to make sure that all the water will flow to the outlet, with no interruption or slackening of the current. The grade, or rate of fall, should be not less than 3 inches to each 100 feet. The rate of fall may be increased toward the outlet, but it should never be lessened without the introduction of a silt well, or settling box, as checking the current in the line may cause the tile to become choked with silt.

Silt wells may be made of brick or concrete and should be at least a foot square inside. The bottom should be a foot lower than the bottom of the tile. The well should have a removable cover, in order that it may be opened once or twice a year for the purpose of dipping out the silt that has settled in the bottom. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with a layer of straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring perfect operation of the drains from the beginning.

#### LIMING

Most of the imperfectly and poorly drained light-colored soils of the uplands and terraces will not produce a satisfactory growth of clover or alfalfa without liming. Alfalfa, however, is not adapted to the Avonburg soils. Furthermore, very acid soil will not respond properly to other needed treatments until it has been limed sufficiently.

Ground limestone generally is the most economical form of lime to use, and sources of supply are fairly convenient. The quantity of ground limestone that should be applied to these soils is shown in the last column of table 14. On the more acid soils, the first application should be at least 2 or 3 tons an acre. After that a ton to an acre every second round of the crop rotation will keep the soil sufficiently sweet for most crops otherwise adapted to the local conditions. To determine the lime requirement in any particular case, the soil should be tested for acidity. The test is simple and should not be neglected. If the farmer cannot make the test, he can have it made by the county agricultural agent, the vocational agriculture teacher, or he can send representative samples of the soil and subsoil to the Purdue University Agricultural Experiment Station at La Fayette.

#### ORGANIC MATTER AND NITROGEN

All the soils of the imperfectly and poorly drained light-colored soils of the uplands and terraces are naturally low in organic matter and nitrogen. Constant cropping without adequate returns to the land are steadily making matters worse. In many places the original supplies of organic matter have become so reduced that the soil has lost much of its natural mellowness and easily becomes puddled and baked. The only practical remedy for this condition is to plow under more organic matter than is used in the processes of cropping. Decomposition is constantly going on and is necessary to maintain the productivity of the soil. Decomposing organic matter must usually supply the greater part of the nitrogen required by crops. For this reason, legumes should provide large quantities of the organic matter to be plowed under.

The acid soils should be limed and otherwise put in condition to grow clover and alfalfa, and these or some other legume should appear in the crop rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized for livestock; and all produce not utilized, such as cornstalks, straw, and cover crops, should be plowed under. It must be remembered that legumes are the only crops that can add appreciable quantities of nitrogen to the soil. Wherever clover seed crops are harvested, the threshed haulm should be returned to the land or plowed under.

Cornstalks, straw, or other crop residues should not be burned, as burning destroys both organic matter and nitrogen. Modern plows

equipped with Purdue or other efficient trash shields will turn down and completely cover cornstalks or other heavy growth. Cover crops should be grown wherever possible, to supply additional organic matter for plowing under. Sowing sweetclover, drilling soybeans between the corn rows at the time of the last cultivation, and seeding rye as a cover crop early in the fall on cornland that is to be plowed the following spring are good practices for increasing the supply of both nitrogen and organic matter. It is important to have a growing crop of some kind on these soils during winter, because without living crop roots to take up the soluble nitrogen from the soil water, large losses through drainage may occur between crop seasons. In this latitude the ground is not frozen at times during winter, and heavy rains may cause much leaching and loss of plant nutrients, especially nitrates, if not taken up by crops.

### CROP ROTATION

With proper drainage, liming, and fertilization, the imperfectly and poorly drained light-colored soils of the uplands and terraces will produce satisfactorily most crops adapted to the locality, although their adaptability to crops varies somewhat. Because of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another.

Corn, wheat, and clover or mixed clover and timothy constitute the best short rotation for general use on these soils after liming, especially where the corn can be cut and the ground disked and properly prepared for wheat. The corn, wheat, and clover rotation can be lengthened to 4 or 5 years by seeding timothy, lespedeza, and alfalfa with the clover and allowing this mixture to stand for 2 or 3 years, to be used for either hay or pasture.

The 4-year rotation of corn, soybeans, wheat, and clover or mixed clover, alfalfa, lespedeza, and timothy is well adapted to these soils. In this rotation, rye should be seeded in the cornfield as a winter cover crop and plowed under late in spring in preparation for the soybeans. Wheat should be seeded in the soybean stubble without plowing. The two legumes will build up the nitrogen supply of the soil if reasonable quantities of the produce find their way back to the land in one form or another. The soybean straw, or its equivalent in manure, should be spread on the wheat in winter. This not only will help the wheat and lessen winter injury, but also will help to insure a stand of clover. Spring small grains are not well adapted to the climatic conditions of this section of the State and, as a rule, are not to be recommended. In special situations where oats are wanted, one of the newer, early maturing varieties should be used.

If more corn is wanted than the 3-year or 4-year rotations will provide, as on intensive livestock farms, the 5-year rotation of corn, corn, soybeans, wheat, and clover or mixed seeding may be used satisfactorily where the second corn crop, at least, can be given a good dressing of manure. Where enough livestock is kept to utilize all the feed grain and roughage in this rotation, enough manure should be produced to make a fair application for each corn crop. A cover crop of rye for plowing under the following spring should be seeded in September on all the cornland.

To guard against clover failures in any of the suggested crop rotations, which may be caused by unfavorable weather conditions even though

the land has been properly limed and is kept in a good state of fertility, it has proved to be a good plan to sow a mixture of seeds made up of about 3 pounds of red clover, 3 pounds of alfalfa, 2 pounds of alsike clover, 2 pounds of timothy, and 4 pounds of Korean lespedeza an acre. If this fails to make a satisfactory stand, soybeans make a good substitute hay crop.

### FERTILIZATION

The imperfectly and poorly drained light-colored soils of the uplands and terraces are naturally low in phosphorus, and in most of them the available supply of this element is so very low that the quantity required by crops should be wholly supplied in applications of manure and commercial fertilizer. The nitrogen supply is also too low to meet the needs of corn, wheat, and other nonleguminous crops, and provisions for adding nitrogen should be an important part of the soil improvement program. The total quantity of potassium is large, but in most of the acreage the available supply is low and the addition of some potash fertilizer will be profitable, especially where little manure is applied. Without substantial provision for supplying all three of these fertilizer elements, the productivity of these soils will remain relatively low.

The problem of supplying nitrogen has been discussed in connection with provisions for supplying organic matter. Legumes and manure are the logical materials for supplying the greater part of this element needed by crops, and they should be employed largely for this purpose. A system of livestock farming with plenty of legumes in the crop rotation is best for these soils. It will pay on most farms, however, to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Even though wheat follows soybeans or other legumes, it should receive some fertilizer containing nitrogen. The residues of an immediately preceding legume do not become available quickly enough to be of much help to the wheat in the fall. The leguminous residue must first decay and that does not take place to any great extent until the following spring.

Where a good clover or other legume sod is not available for the corn crop and little or no manure is applied, it will pay to plow under 300 to 400 pounds of ammonium sulfate or cyanamid along with liberal quantities of phosphate and potash.

Phosphorus is the mineral plant nutrient in which these soils are most deficient. In all, the natural supply is small and should not be drawn on further. The only practical way to increase the supply of phosphorus in the soil is through the application of purchased phosphatic fertilizers, and it will prove profitable to supply more than the crops to be grown actually need in order to raise the productive capacity of the soil. In rotations of ordinary crops producing reasonably satisfactory yields, 20 pounds of available phosphoric acid an acre are required each year to produce the crops, and since large proportions of the phosphates applied are fixed by the soil in forms not available to the crop, larger quantities should be used. Where manure is applied, it is estimated that each ton supplies about 5 pounds of phosphoric acid; therefore, a correspondingly smaller quantity need be provided in the commercial fertilizer.

The quantity of potash that should be supplied as fertilizer depends on the general condition of the soil and the quantity of manure used. According to the analyses in table 13, most of the soils of this group are medium to low in available potash and require more or less potash fer-

tilizer. In building up a run-down soil, considerable quantities of fertilizer potash should be used, at least until such time as considerable quantities of manure can be applied. There is plenty of potassium in these soils for all time if it could be made available at a faster rate. As a rule it becomes available too slowly. This is particularly true of the flat poorly drained gray soils, and the fertilizer for these should contain more potash than that for the imperfectly drained brownish-gray soils.

The availability of the soil potash may be increased by good farming practices, including drainage, proper tillage, growing deep-rooted legumes, and plowing under liberal quantities of organic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

In the practical fertilization of these soils, most of the manure should be plowed under for the corn crop. When the crop rotation includes wheat, as should generally be the case, a part of the manure (about 2 tons an acre) may be applied profitably on the wheatland as a top dressing during winter. Manure so used not only helps the wheat and lessens winter injury but also helps to insure a stand of clover or other crop seeded in the wheat. In addition to the manure, corn should receive 100 to 150 pounds an acre of a phosphate and potash mixture, at least as high an analysis as 0–12–12, applied in the row or beside the hill at planting time. Wheat should be given 200 to 300 pounds an acre of a high-analysis complete fertilizer, which may be 2–12–6, 2–16–8, or 3–12–12, depending on the quantity of manure used in the rotation. In places where the wheat is backward in spring, a top dressing of about 100 pounds an acre of a soluble nitrogen fertilizer should be applied soon after growth begins. Such top dressing generally will add 5 to 7 bushels an acre to the yield.

On run-down land or land of naturally low productivity for which heavy applications of manure are not available, it will pay to start with at least 500 pounds of a 10–10–10 or 8–8–8 fertilizer, or its equivalent, plowed under for corn, and to accompany this with 100 pounds an acre of 3–12–12 in the row or beside the hill at planting time. Such fertilization has been found profitable in experiments on similar soils in other parts of the State.

Where soybeans follow heavily fertilized corn, as should usually be the case, they need not be specially fertilized. If the land to be planted to soybeans has not been heavily fertilized for the preceding crop, most of the fertilizer needed should be plowed under and only a small quantity applied when drilling in the seed, because soybeans are sensitive to fertilizer injury during germination and early growth if much fertilizer is applied with the seed. Usually the 0–12–20 analysis should be used at the rate of 300 to 400 pounds an acre, of which two-thirds should be plowed under.

For special crops, special fertilization will be needed. Specific fertilizer recommendations for different crops on different soils under different conditions can be procured from the Purdue University Agricultural Experiment Station at La Fayette.

### WELL TO EXCESSIVELY DRAINED, WELL-DRAINED, AND MODERATELY WELL-DRAINED LIGHT-COLORED SOILS OF THE UPLANDS AND TERRACES

The group of well to excessively drained, well-drained, and moderately well-drained light-colored soils of the uplands and terraces comprises the

loams of the Miami, Bellefontaine, Fox, Nineveh, and Martinsville series; the silt loams of the Miami, Russell, Fox, Martinsville, Cincinnati, Gibson, Wellston, and Zanesville series; Muskingum stony silt loam; and Princeton fine sandy loam. These soils occupy 72,896 acres, or 35.2 percent of the total area of the county, with Miami silt loam and its phases occupying 19.1 percent. Muskingum stony silt loam, Cincinnati silt loam, steep phase, Fox loam, sloping phase, and Miami silt loam, gullied phase, comprising 1.6 percent of the total area of the county, are unfit for cultivation and are classed as nonarable soils. These soils are discussed under that heading.

The arable soils of this group, although differing more or less, owing to the differences in parent material, topography, texture, and depth of leaching, have certain characteristics in common, in respect to which their management problems are similar. Their adaptation to crops, however, is uniform. All are low in organic matter, nitrogen, and phosphorus. Natural drainage is moderately good to excessive. The heavier textured soils, including the Miami, Russell, Cincinnati, Gibson, and Zanesville silt loams, are subject to excessive runoff in times of heavy rains, while the Fox, Nineveh, and Martinsville loams and Princeton fine sandy loam, which are more open textured, are more liable to suffer from drought. The Fox, Nineveh, and Martinsville soils occur on nearly level relief, and therefore are not subject to injury from erosion as are the soils of the first mentioned group. Thus management practices on them are somewhat different from those of the other soils of this group.

### CONTROL OF EROSION

On most of the well to excessively drained, well-drained, and moderately well-drained light-colored soils of the uplands and terraces the problems of controlling erosion are of major importance in practical systems of soil management. Even after taking out of cultivation all the rough and very sloping land, which should never be plowed, the rest of the tillable land needs special care in order to prevent further destructive erosion. In places the surface soil already has gone, and further sheet erosion and gullying are constantly making matters worse. The surface soil contains the greater part of the store of fertility and should be protected against erosion by every practicable means. Gradual sheet erosion, whereby the runoff of rain water moves the surface soil down the slope a little at a time and rather evenly, is the most insidious form of erosion and may not be noticed until the subsoil begins to appear. Many onetime fertile fields have been irreparably damaged in this way, and many others have only a little of the surface soil left, and the plow reaches into the unproductive subsoil.

Plowing and other tillage operations should extend crosswise of the slopes wherever possible, in order to prevent the formation of watercourses down the slope, which carry away much valuable surface soil and may start serious gullies. Contour plowing and contour strip cropping may be most practical on fields of irregular slopes, whereas terracing may be most practical on long even slopes. By rearranging fences or other field boundaries, it may be possible to arrange the cropping system in such a way as to facilitate the performance of all tillage operations crosswise of the slopes. Intertilled crops should be interspersed with small-grain and sod-forming crops. Incipient gullies, or draws, forming natural waterways down the slopes, should be kept permanently in

grass, with a good sod of sufficient width to allow the water to spread and thereby prevent soil cutting.

### LIMING

Nineveh loam and some small areas of Fox, Princeton, and Bellefontaine soils of the well to excessively drained, well-drained, and moderately well-drained light-colored soils of the uplands and terraces are slightly acid and in no immediate need of liming. The greater part of the Bellefontaine and Fox soils, however, are medium acid, and the rest medium to strongly acid, and liming should be a first step in their improvement. What has been said about the liming of the imperfectly and poorly drained light-colored soils of the uplands and terraces applies equally well here and should receive early consideration in plans for making these soils more profitably productive.

### ORGANIC MATTER AND NITROGEN

The soils of the well to excessively drained, well-drained, and moderately well-drained light-colored soils of the uplands and terraces are similar to those of the more poorly drained group in their organic matter and nitrogen content, and what has been said about ways and means and the importance of increasing the organic matter and nitrogen content of those soils applies equally well here. In fact, the soils of this group are especially in need of more organic matter in order to improve their permeability to rain water and thereby lessen surface runoff and erosion damage.

### CROP ROTATION

With proper liming and fertilization, the well to excessively drained, well-drained, and moderately well-drained light-colored soils of the uplands and terraces will produce satisfactorily most crops adapted to the locality. On account of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat, and clover or mixed clover and timothy constitute the best short rotation for general use on these soils after liming, especially where the corn is cut and the ground disked and properly prepared for wheat. The corn, wheat, and clover rotation can readily be lengthened to 4 or 5 years by seeding timothy, lespedeza, and alfalfa with the clover and allowing the stand to be used 2 or 3 years for either hay or pasture.

The 4-year rotation of corn, soybeans, wheat, and clover or mixed clover, alfalfa, lespedeza, and timothy is well suited to these soils. In this rotation, rye with fertilizer should be seeded in the cornfields as a winter cover crop to lessen erosion and to conserve plant nutrients, which otherwise might be lost by leaching, and this should be plowed under late in spring in preparation for soybeans. The wheat should be seeded in the soybean stubble without plowing. The two legumes will build up the nitrogen supply of the soil. The soybean straw, or its equivalent in manure, should be spread on the wheat in winter.

On livestock farms where there is need for more corn than the 3- or 4-year rotations can provide, the 5-year rotation of corn, corn, soybeans, wheat, and clover or mixed seeding may be used if the soil erosion hazard can be dealt with satisfactorily. Where enough livestock is kept to utilize all the feed, grain, and roughage in this rotation, there should be enough manure produced to make a fair application for each corn crop.

A cover crop of rye for plowing under the following spring should be seeded in September on all the cornland.

Cropping systems on the rolling uplands should generally contain a large proportion of sod-forming crops, and winter cover crops after corn or soybeans are especially important because of the ever present erosion control problem. Under such conditions contour strip cropping should be practiced as much as possible, with grain and sod crops alternating. On the other hand, on some of the terrace loams and silt loams in this group of soils, erosion is not much of a problem, but corn usually suffers seriously from drought. Wheat is the most important grain crop on terrace soils; soybeans may be more extensively used to good advantage because they stand periods of drought better than corn. Where sweetclover does well in such situations, a short rotation of wheat and soybeans has possibilities, with sweetclover seeded in the wheat as an intercrop to be plowed under with phosphate and potash fertilizer for the soybeans.

Alfalfa and sweetclover may be grown on the Miami, Russell, Fox, Martinsville, Bellefontaine, Nineveh, and Princeton soils if properly inoculated and sufficiently limed to meet the needs of these crops. In particular, these deep-rooted legumes may be recommended for Princeton fine sandy loam and for the Fox, Nineveh, Martinsville, and Bellefontaine soils, which have calcareous gravelly and sandy subsoils and which are somewhat droughty for other crops. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and soil improvement purposes. Special literature on the cultural requirements of these crops may be obtained from the Purdue University Agricultural Experiment Station at La Fayette.

The more droughty and sandy soils are also adapted to truck and cannery crops, as melons, early potatoes, tomatoes, sweet corn, and cannery peas and certain fruits. This is especially true of Princeton fine sandy loam. A 5-year rotation of melons (rye and vetch cover crop), early potatoes (rye and vetch cover crop), tomatoes, and alfalfa for 2 years is well suited to the sandy soils on which these crops can be grown to advantage. Success with this rotation will depend largely on the success with the cover crops and alfalfa. All crops should be fertilized. Where alfalfa responds to additions of lime, it will be advisable to confine liming to drilling 300 to 400 pounds an acre of ground limestone with the alfalfa seed each time this crop is sown, because heavier liming may be detrimental to the potatoes and tomatoes. Alfalfa seeding should be made immediately after potato harvest and the cover crop seeded as soon as possible after harvesting the melons.

#### FERTILIZATION

The general discussion of the plant-nutrient requirements of the imperfectly and poorly drained light-colored soils holds also for this group of light-colored soils, except that these soils generally are not so much in need of potash fertilizer because decomposition of the potassium minerals naturally in the soil proceeds more rapidly. The natural supplies of nitrogen, organic matter, and phosphorus are practically the same as found in the imperfectly and poorly drained light-colored soils. On the better drained soils that are not too droughty, however, the more desirable soil improvement legumes are more dependable for supplying nitrogen and organic matter, but, on the other hand, consumption of these materials is accelerated by the better aeration, which goes with better drainage, and by unavoidable losses due to erosion. For the more spe-

cialized truck crops that may be grown on those soils, heavy applications of high-analysis complete fertilizer are usually needed. Five hundred to 1,000 pounds an acre of 2–12–6, 2–16–8, or 3–12–12 is commonly recommended. Specific recommendations for specified crops can be procured from the Purdue University Agricultural Experiment Station at La Fayette. For alfalfa, 300 to 500 pounds an acre of a high-grade phosphate-potash mixture should be applied at seeding time.

## DARK-COLORED SOILS

The group of dark-colored soils comprises the silty clay loams of the Brookston, Clyde, Westland, Abington, and Mahalasville series, and Carlisle silty muck and occupies 53,120 acres, or 25.8 percent of the total area of the county.

These dark-colored soils were all developed under more or less wet conditions and, in consequence, a common natural defect is poor drainage. After drainage, they are the strongest and most productive soils in the county. The natural fertility level is relatively high and additions of fertilizer are not yet urgently needed. The chemical tests show fair to good supplies of available phosphorus and potassium, and the nitrogen and organic matter supplies are fairly ample.

### DRAINAGE

All the dark-colored soils are naturally wet and more or less in need of artificial drainage. To a large extent this has been provided, and surplus water is fairly well taken care of. In many places, however, there would be good response to more tiling. Where this is needed, the same procedure should be followed as that suggested for the imperfectly drained and poorly drained light-colored soils of the uplands.

The spacing of tile drains in the various types depends upon the character of the subsoil and substrata. Westland and Abington soils are underlain by loose gravel and sand, and adequate artificial drainage can be obtained by lowering the water table in this strata.

### LIMING

The dark-colored soils are neutral or only slightly acid and do not need liming for the ordinary crops.

### CROP ROTATION

The dark-colored soils are especially well suited to corn, and this may well be the major crop. Among the crop rotations that may be satisfactorily used are the following: Corn, wheat, and clover; corn, soybeans, wheat, and clover; corn, corn, soybeans, wheat, and clover. Usually some timothy is seeded with the wheat in fall, and many farmers who have their land well drained are mixing some alfalfa with the clover for sowing in the wheat in spring.

### FERTILIZATION

Manure and fertilizer are not so necessary on these dark-colored soils as on the lighter colored ones with which they are associated. Wheat, however, generally should receive 200 to 300 pounds an acre of a complete fertilizer, as 2–12–6, 2–16–8 or 3–12–12 both for itself and for the seeding to follow. Corn generally should receive 100 to 150 pounds an acre of a phosphate-potash mixture, as 0–12–12 or 0–20–20 beside the hill or in the row at planting time. On farms having both light- and

dark-colored soils, the manure should be applied to the light-colored soils, because they are more in need of the organic matter and nitrogen it supplies.

## SOILS OF OVERFLOW BOTTOMS

The soils of the overflow bottoms, or alluvial soils, are grouped into two general classes—the strongly acid soils and the neutral or slightly alkaline soils. The strongly acid soils, including Philo and Pope silt loams, occupy 576 acres, or only three-tenths of 1 percent of the total area of the county. Formed by deposits from the strongly acid soils of the uplands and terraces, these soils should receive 2 to 3 tons of ground limestone an acre based on tests for acidity. The neutral or slightly alkaline soils include Genesee and Eel loams and silt loams, Eel and Ross silty clay loams, and Genesee fine sandy loam. Formed by deposits from the soils of the uplands and terraces in the regions of Wisconsin glaciation, these soils occupy 20,928 acres, or 10.3 percent of the total area of the county and are not in need of liming.

### DRAINAGE

Natural drainage of the alluvial soils is limited by the periodic overflows and, in the heavier types, by tight subsoils. The latter should be tile underdrained wherever suitable outlets can be obtained, in order that the land may drain more quickly after floods or heavy rains.

### ORGANIC MATTER AND NITROGEN

Eel and Ross silty clay loams of the overflow bottoms have fair supplies of organic matter and nitrogen, but the other soils of this group are in need of additional supplies of these important soil constituents. What has been said about supplying organic matter and nitrogen to the light-colored soils of the uplands and terraces applies equally well to the light-colored soils of the bottom lands. On the lighter colored and poorer areas of these soils especially, considerable quantities of organic matter should be plowed under, and legumes should be included in the rotation wherever possible and largely returned to the land in one form or another, in order to increase the nitrogen content.

Where the land is periodically flooded, clover and other deep-rooted legumes, especially biennials and perennials, cannot be depended on, but certain shallow-rooted legumes, as soybeans, cowpeas, and sometimes alsike clover and lespedeza, can be grown satisfactorily. These crops should be used largely for gathering nitrogen from the air, which they will do in large measure when the soil is properly inoculated. Cover crops, as soybeans and rye, should be used to the fullest possible extent in the cornfields. Cornstalks should not be burned but should be completely plowed under whenever practicable.

### CROP ROTATION

Where overflows cannot be prevented on the alluvial soils, the crop rotation must consist largely of annual spring-seeded crops and such grass and clover mixtures as will not be seriously injured by ordinary floods. For the most part, corn, soybeans, and in some places where flooding is not too prolonged, wheat with a mixture of timothy and alsike clover following for a year or 2, are satisfactory crops for this land. Corn should doubtless continue to predominate, but some sort of rotation is advisable to help maintain fertility. Doubtless, soybeans will

become more important as a rotation crop on these soils if proper inoculation is provided. Mixed timothy and alsike will do well on most of this land after the strongly acid areas have been limed, and this crop may be allowed to stand for more than 1 year and utilized as hay or pasture. In places where the land is too acid for alsike, lespedeza may be used. For late seeding in emergencies, early varieties of soybeans and Sudan grass, for either hay or seed, will be found useful. On some of the better areas where flood hazards are not great, short-season truck crops and alfalfa may be grown successfully.

#### FERTILIZATION

Eel and Ross silty clay loams of the overflow bottoms and some areas of Eel and Genesee silt loams are still fairly well supplied with available plant nutrients, but Eel and Genesee loams, Genesee fine sandy loam, and Pope and Philo silt loams are low in nitrogen and medium to low in available phosphate and potash. The floodwater deposits that come to these bottom lands from the adjoining watersheds are not so rich as they were years ago and more commonly consist of eroded subsoil material of low fertility.

In the practical fertilization of crops where yields are unsatisfactory, it will pay to apply 150 to 200 pounds an acre of 0–12–12 or 0–20–20 in the row or half that quantity beside the hill for corn. Where the flood hazards are not too great it may pay, on the poorer soils at least, to apply larger quantities of fertilizer by the plow-under method accompanied by row applications of complete fertilizer, as suggested in the discussion of fertilization of the poor light-colored upland soils. Where wheat is grown, it should receive from 200 to 300 pounds an acre of complete fertilizer at least as good as 2–12–6. Response of soybeans to fertilizer is less certain, but where fertilizer is needed this crop should receive a phosphate-potash mixture broadcast before plowing or applied through a modern fertilizer attachment on the plow.

### NONARABLE SOILS

The more sloping, eroded, and gullied phases of the Cincinnati, Zanesville, Russell, Miami, and Fox soils, and practically all of Muskingum stony silt loam are not suited to ordinary farming purposes and should be regarded as nontillable and kept out of cultivation. Some of this land that has been cleared may be put into permanent pasture by seeding to a mixture of bluegrass, redtop, and lespedeza, but much of it should be reforested and given protection from livestock as the most practical means of saving it from erosion. Where it seems feasible to establish pasture on acid soil areas of nontillable land, the chances of success may be greatly improved by applications of 1 to 2 tons of ground limestone and 300 to 400 pounds of superphosphate an acre, either on top of present stands or before fresh seedings. Establishment of a good vegetative cover to hold the soil in place is essential. Contour furrows on hillsides and dams or other engineering devices in gullies should be employed wherever practicable, but undistrubed forest or a solid vegetative cover of some other kind should be the ultimate aim.

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Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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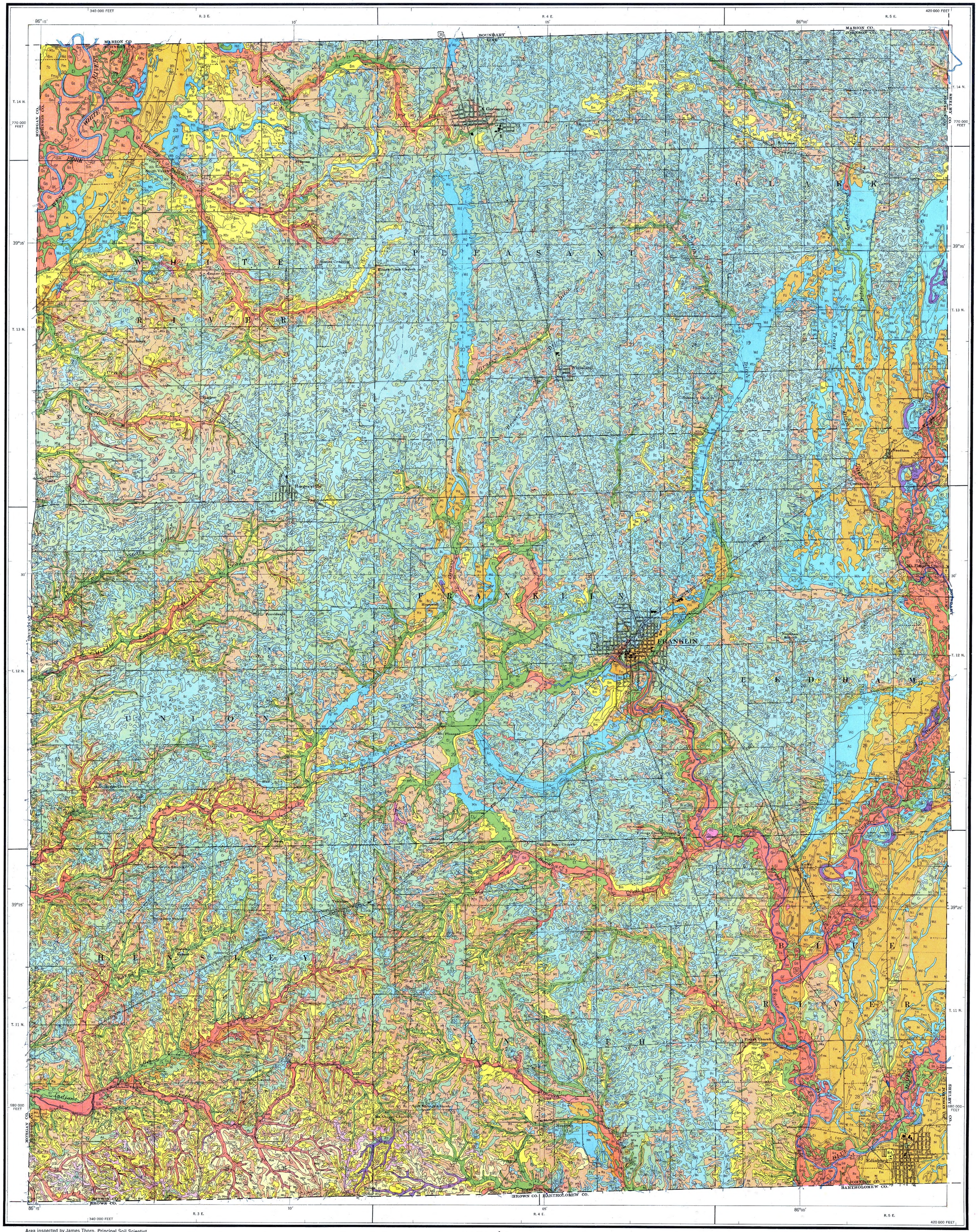
U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
ROBERT M. SALTER, CHIEF
DIVISION OF SOIL SURVEY, CHARLES E. KELLOGG, CHIEF
MAP DRAFTING, J. W. McKERICHER, IN CHARGE

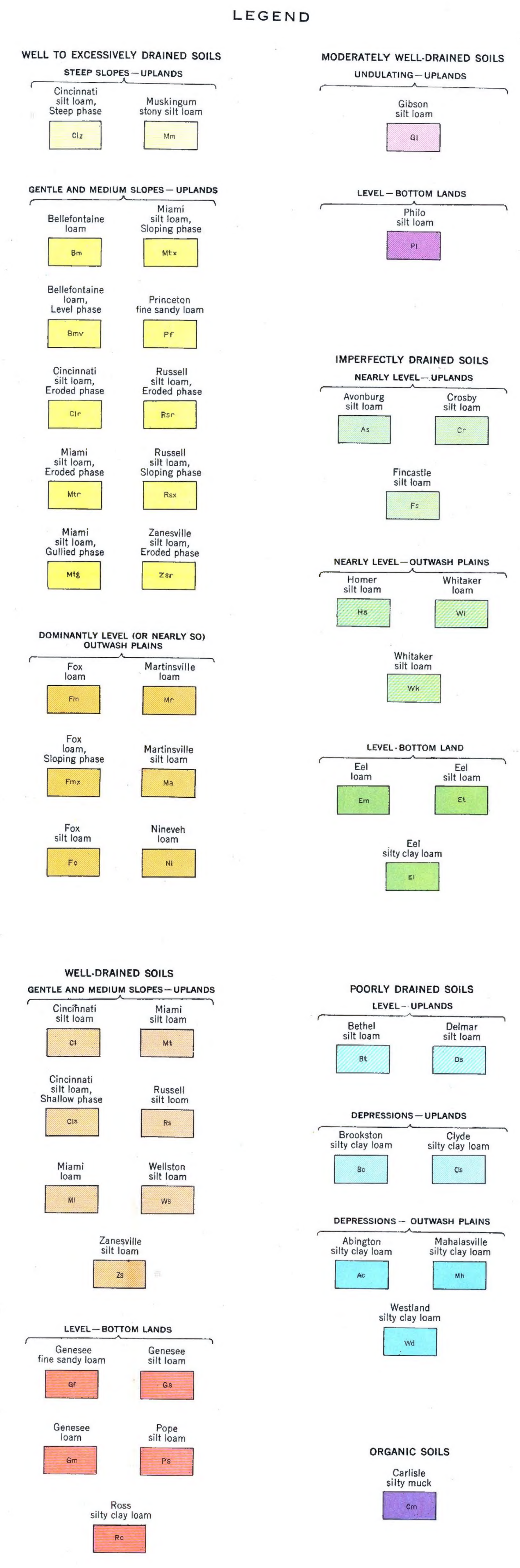
# SOIL MAP

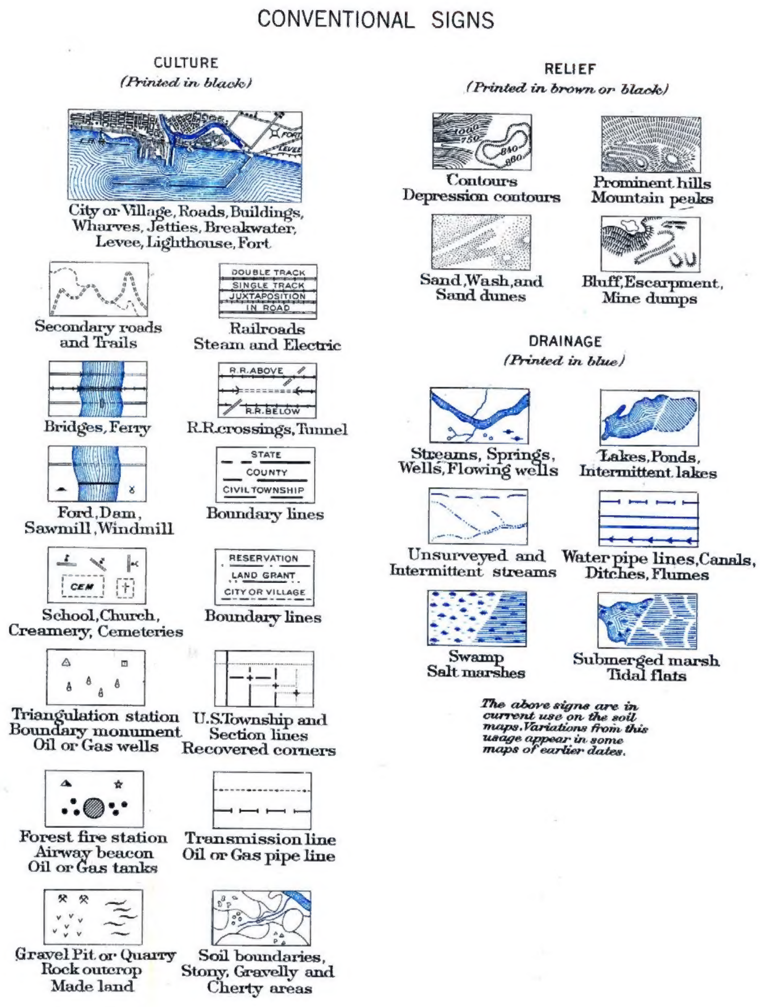
JOHNSON COUNTY

INDIANA

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
H. J. REED, DIRECTOR
A. T. WIANCKO, CHIEF, DEPARTMENT OF AGRONOMY
T. M. BUSHNELL, ASSOCIATE IN SOIL SURVEY




Area inspected by James Thorp, Principal Soil Scientist.
Soils surveyed by H. P. Ulrich, in charge, T. E. Barnes, A. P. Bell, Sutton Myers, T. E. Nivison, and P. T. Veale, Purdue University Agricultural Experiment Station.

Scale $\frac{1}{48,000}$

1 ½ 0 1 2 3 Miles

5,000 0 5,000 10,000 Feet

Polyconic projection, 1927 North American datum.
Horizontal control by, U. S. G. S. and U. S. C. and G. S.
Base map in part from aerial photographs.
10000 foot grid based upon Indiana (East) system of plane coordinates.
Surveyed in 1937-38. Series 1938.